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THE EDISON-SWAN MONOPOLY.

THE decision of Mr. Justice Kay on Monday morning is the most important event of the last few years to the electric light industry. Mr. Justice Kay has studied the whole case with the greatest care, and his judgment is thoroughly well considered, and, we feel, perfectly just. The Edison lamp monopoly now seems to be completely destroyed. The judgment is so strong, and the conclusion depends so little on legal opinions and so much on facts, that we think there is no doubt that the judgment will be supported. The case will probably go to appeal, and perhaps to the Lords, for the policy of the Edison-Swan Company will probably be to intimidate the industry as much as possible by advertising that they have several judgments in their favour, and only one against them, and that people will use other lamps on peril, as the validity will be sustained on appeal, and proceedings will then be taken.

The history of the modern incandescent lamp is roughly as follows. In 1836 carbon in a vacuum was well known. In 1840 to 1860 various attempts were made by King and others with bad vacua. When the dynamo and arc lamp became a commercial success new impetus was given to the search. Lane-Fox knew all the requisites, and seems to have been a wonderfully far-seeing inventor. He tried platinum, alloys, and carbon pure and mixed with earthy matters. Swan about this time was working at low resistance high vacuum lamps. In America Maxim seems to have been ahead of others, and was working with carbon deposited by electrical heating. About 1880 Swan began to make really commercial incandescent lamps. Lane-Fox was in the market about the same time, or soon after, and so was Maxim with his American lamps, made of paper. It was certainly Swan and Lane-Fox who made lamps a commercial success in this country, and the Edison lamp did not really appear till the end of 1881. The Edison lamp of 1881 had nothing in common with the lamp described in the notorious patent, but it was included in the claim. It was made under a number of Edison's subsequent patents, and, no doubt, was largely the result of subsequent knowledge gained from other workers. The 1879 patent is simply a sort of fishing specification. Edison thought lamps might be made with high resistance carbons, so he took out a patent to cover them as soon as they appeared.

The attack on Edison's patent was very much stronger than in the Woodhouse and Rawson action. In the former case, for some unaccountable reason, nothing was made of the insufficiency of the specification, and the statement that lamps were brought into commercial use by Edison passed unchallenged.

Edison was supposed to have invented forming the conductors before carbonisation, while all the time the Swan stick lamp had such a conductor. It is to us strange that Mr. Swan should allow such a misapprehension to exist when he could have corrected it, his having had a subpoena from Woodhouse and Rawson notwithstanding. In fairness he should have told one side or the other. Mr. Swan's position was, however, very peculiar, and must have also been exceedingly painful; and though it seems odd to us, we have little doubt that his conduct in the matter would appear perfectly fair if we knew all the circumstances. The Edison-Swan Company do not seem to have consulted him at all, and being called by the other side against his will, he was not bound to help them. All the same, an action affecting a whole industry should not have been fought on a false basis. When Mr. Swan was in the witness box in the recent action, he seemed singularly anxious to explain everything with perfect fairness to both sides, and his evidence threw much light on the case.

We do not propose to discuss the patent, or the action in detail at length. The duration and the expense of the trial are very much to be regretted; all that money has been wasted as far as our industry is concerned. The evidence, especially that on the plaintiffs' side, appeared to us to savour too much of argument on oath. The judge frequently had to check the witnesses. Some of the answers were certainly attempts to mislead the judge. For instance, in the duration tests the lamps were run at from 10 to 15 watts per candle. To an untechnical man this conveys little, but everyone who knows anything about lamps knows that it is an absurdly low temperature; yet the witnesses swore it was a fair test for 1879. Of course, in 1879, there were no carbon lamps, but platinum lamps ran much higher than 15 watts. When carbon lamps came into use 3 to 4 watts per candle was about the usual brightness. Edison's were generally about 5 watts per candle, but his lamps have never been able to stand high temperatures. If they are run at 15 watts, Mr. Finlay's suggestion of 4 candle-power for a 16 candle lamp is about right. As it was obviously difficult to explain all this to the judge at the end of the case, such evidence on the part of the plaintiffs was really not fair. We have been told that the duration tests of the experimental lamps with spiral filaments made under Prof. Stokes's supervision appeared to run at 25 watts, at which an Edison 16 candle lamp gives under two candles, but this impression was due to photometric errors in the system of measurement adopted, the actual trials showing the same result as previously mentioned, viz.: 10 to 15 watts. The lamps also altered their resistance during running.

We shall have some further remarks to make on this trial in our next issue.

WE are glad to see that further confirmation of the several tests which were recently made with Priestman's petroleum engine is now forthcoming. Mr.

William Anderson, the consulting engineer to the Royal Agricultural Society, whose annual show was this year held in Nottingham, and where three of Messrs. Priestman's engines were exhibited, made a trial of a 4 H.P. motor on Saturday, the 5th inst., with very satisfactory results, the figures then obtained entirely corroborating those obtained by Sir William Thomson and ourselves. We shall be glad to learn that this type of engine is in demand, for it certainly deserves a very extended use. This, however, is probably only a question of time, for the engine has only to be seen to be highly appreciated. Only two silver medals were this year awarded by the Society and one of these fell to the lot of Messrs. Priestman, whom we congratulate on their success.

MR. GARCKE deals so copiously in our correspondence columns with the scheme for bringing into existence an electrical section of the London Chamber of Commerce that there is but little left for us to say. We think, however, that a brief comment may not be out of place, the more so as we have had opportunities of carefully considering the matter in most of its bearings. The want of something of the kind has for a considerable time been apparent, but the ideas hitherto promulgated have not enlisted the sympathies of the electrical trades as a whole, neither have they had the general support of the technical press. The objections, however, which were raised to these premature and but superficially thought-out schemes for bringing together a fusion of trade interests do not apply to the London Chamber of Commerce movement, which we consider worthy the serious consideration of both town and country manufacturers, who we hope will readily come forward in cordial support of the proposal. Men like Messrs. Crompton and Garcke are not likely to blunder in a question affecting the interests of the electrical industries, and as they are taking very active steps in this matter, which seems to have their entire approval, we doubt if we could bring forward a more forcible appeal than to suggest that the trade should go and do likewise. The resolution which was formed at the meeting of last Friday may be seen amongst our notes, and we trust that the proposed gathering at Botolph House, Eastcheap, E.C., on the afternoon of the 27th inst., will be thoroughly representative.

On the 23rd of last month Prof. Silvanus Thompson read a paper before the Physical Society on "Continuous Current Transformers." During the discussion he stated that he would not attempt to use a potential difference of 2,000 volts with an ordinary Gramme collector. The learned Professor may doubtless have good reasons for this statement; at the same time, he has probably very exaggerated ideas of the difficulties of insulating the contact bars. Is it not a fact that the dynamo which is used for lighting "Niagara" has a potential of 3,000 volts; that machines of the Woods type are running in many places with the same high potential difference; and that the collector of these machines is of the ordinary Gramme pattern? Mr. Heap could probably give us some interesting information on this vexed question.

It has been stated, on such high authority that we fear to question it, that the Brockie-Pell arc lamp is the only type which will work satisfactorily with constant current or constant potential. We have heard recently of several regulators which are said to possess all the merits of the above-mentioned lamp; perhaps some of our readers can adduce proof of these statements?

It is well known that in all cases where India-rubber is used as an insulator, either pure or in the vulcanised form, the metal should be tinned in the case of copper or brass. This is imperative, as untinned copper decomposes pure rubber, and, at the moment of decomposition, a secondary reaction takes place, the decomposed India-rubber attacking the copper. The failure of many of the early West India cables was, we believe, distinctly traceable to this cause, and some hundreds of knots of the Western and Brazilian Company's cable had to be relaid owing to the same imperfection.

VULCANISED rubber, if made of a mechanical mixture, has always free sulphur in its composition; this acts directly upon the copper if brought into direct contact. It has also the peculiarity of separating itself from the mixture as a body and working outwards, reforming itself on the external surface in hexagonal crystals. Vulcanised rubber is vastly inferior as an insulator to the pure article, and is of many kinds. It may contain 5 per cent. or 75 per cent. of sulphur and the ingredients, which are not by any means insulators, do not tend to retain or preserve the permanency of the insulating covering. Pure rubber, under certain conditions, will absorb 5 per cent. of sulphur in the process of vulcanising; this forms a chemical combination, anything extra is liable to exude.

MESSRS. SHAW AND CONNOLLY'S system of manufacturing insulated conductors is said to differ from that of other manufacturers, in that their outer coverings of pure rubber are vulcanised by absorption only. The use of the white layer in their covering is to prevent any passage of free sulphur from the outer to the inner layer of pure rubber by trapping it, i.e., the sulphur in excess, if any, combines with an oxide to form a sulphate, and, being in chemical combination, is no longer free to act on its surroundings. The wires manufactured by this firm appear to be steadily gaining ground amongst electrical engineers, and this may perhaps be mainly attributable to the experience of Mr. Connolly, who for the past 20 years has been connected with the firms of Hooper, the Telegraph Construction and Maintenance Company, and lastly, as manager and director of Pirelli & Co., of Milan. The method of insulating what the firm terms its 0 quality conductors, may be found in our "Notes" columns.

"It is a common fault of our nature to give greater credence to those things which are unseen, concealed, and unknown, and to be more violently alarmed by them." This, a quotation from Caesar's *Bellum Civile*, might have been written to-day of the fear with which the electric current, or rather its commercial application, is regarded by the general public, and in view of the tremendous outcry occasioned by an exceptional fatality due to the agency of electricity. In the pages of an American contemporary we read that although arc lights were introduced to New York about ten years ago, and there are now some seven thousand of them in use in that city, only four casualties can be traced to their employment. We further read that in the same city, between January and June, 1888, 21 citizens were run over and killed by reckless drivers, and some 139 others more or less injured, while during the same period two citizens were killed by electric wires in the streets. These figures speak for themselves, and yet more fuss was made about the two people killed by electricity, than over the whole of the killed and injured by reckless driving.

It does not seem that the owners of certain patents relating to electric lighting have had an altogether happy time in the United States. Siemens attempted to secure the control over the modern type of dynamo, but failed; the Gramme Syndicate were defeated in a similar endeavour; the Brush Company vainly attempted to apply its patent to the arc lamp; and now the Edison incandescent lamp patents appear doomed to share the same fate. The New York *Electrical Engineer*, in calling attention to the very small returns from electric lighting enterprises compared with the vast sums invested in them, points out that the present state of affairs is an exact counterpart of the condition of the telegraphic service some thirty years ago.

WE will undertake to say that very few people have the slightest idea of the detriment to trade which is occasioned by such actions as the one just decided between the Edison-Swan Company and the Anglo-American Brush Corporation. The defendants, of course, could not launch out into more extensive manufactures during the legal proceedings, considering the uncertainty of judgment in patent cases; and although they are now free to construct lamps as fast as they please, the victory must have cost them dear. If, again, as a matter of form, an appeal is made, costs will be stayed during that period; the public will be led to believe that the judgment may be reversed, and we find the defeated company in the peculiar position of remaining through the monopoly of the past, and the prestige still attaching to the name of Edison and Swan, practically masters of the situation so far as the selling of lamps is concerned, for, until the appeal is settled, the public will be chary of purchasing from other firms.

THERE is one point in the Report which Prof. Stokes submitted to the judge in the just completed incandescent lamp patent case which must have struck everybody who perused it, and that is that the filaments made by both parties for the purpose of the tests were not worth a cent.

WE suppose that the Edison-Swan Company will go to the Court of Appeal as a matter of form, but we rather fancy that Mr. Justice Kay's judgments are not generally reversed on an appeal.

A WELL-KNOWN electrical company, which has already figured in a similar trial to that above mentioned, is disposed to think that to the general industry Mr. Justice Kay's judgment is adverse, but that as to its own business it is just the thing, as the filaments it uses are said to be manufactured without the flashing process.

WE understand that the Anglo-American Brush Corporation has actions pending against the Edison-Swan Company, based upon the alleged infringement by the latter of several points covered by the Lane-Fox patents.

It is admitted that the Brush Company's filaments are standardised by a flashing process, and the question is whether the Cheesbrough patent for building up defective carbons can be held to include the electro-deposition of carbon from hydro-carbons upon already good filaments? We believe that the Brush Company does not recognise the Cheesbrough patent in connection with the modern flashing of filaments for standardising, but a correspondent writing to us on this point says:—"As the Brush Company flash, I presume they will discontinue making lamps unless they take a licence from Seel or the Consolidated Company to work under their patents."

Is the Cheesbrough patent actually held by the Edison-Swan Company, or does it only possess a license obtained by certain means which may at any moment be revoked? Col. Davis, of the Consolidated American Company, could throw a little light upon this point if he so desired.

MR. ARTHUR SHIPPEY, who is now in Berlin, and whose opinions are generally accepted as gospel, says that the only valid patent now in existence is the "Seel" system of constructing filaments from solidified hydro-carbons. He gives a number of reasons for his assertion, all of which may contain some particle of truth, but which, after all, can carry no weight, and therefore we do not purpose presenting them to our readers. The validity of the Seel patent may possibly be tested in a court of law where matters of opinion have to give way to matters of fact, or at least they should do so.

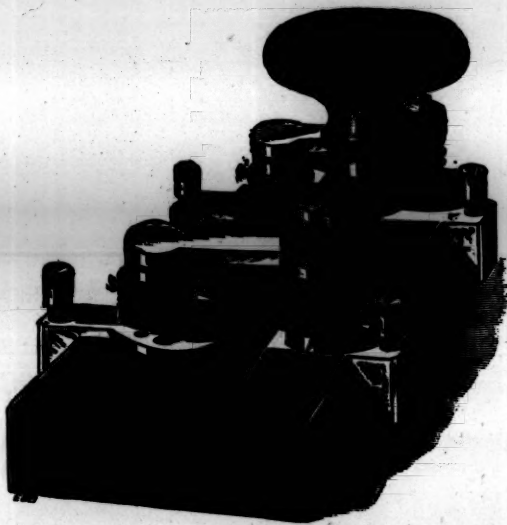
It seems more than probable that the Consolidated and Westinghouse Companies of America will now come into the English market with lamps of their own manufacture. The former company with the Sawyer-Man patents, and the Westinghouse people effecting a combination with the Seel system, might be strong enough to seriously compete with the producers for the British market. Lamps would be cheaper, electrical plant all round would be in greater demand, and the suggestion we have here thrown out does not seem by any means impossible to realise.

IN "Practical Electricity" (an American publication), we have a description of a new primary battery, the invention of Messrs. Ward and Sloane. The battery has for its elements zinc and carbon rods, separated by a porous pot, and immersed in solution whose composition is kept secret. The E.M.F. of the cells is stated to be as high as 2.87 volts, a result which we believe to be impossible with a zinc-carbon combination, no matter what fluids are used for excipients. It is mentioned that a cell gave a current of 10 amperes for 30 hours without any fall in the E.M.F., a result we should mention which is no better than that given by the Weymersch combination, the results of tests of which we gave in our issue of the 22nd June last. The article describing the battery says:—"We will add, for the gratification of the sceptical, that there has been no unsealing of the cells. Hence, at the present writing, we cannot give any estimate, even approximately, of the weight of zinc which has been consumed." Considering that the consumption of zinc is one of the most important elements to be considered in the efficiency of a battery, the expression of opinion that "it is the most remarkable voltaic cell that has ever been brought to our notice" does not go for much.

THE *Times*, in a leader on the suit between the Edison-Swan Company and the Anglo-American Brush Corporation, says that the result of the action curiously resembles that attained by the process of "splitting the difference." It leaves the Edison-Swan Company, says our ponderous contemporary, in possession of a remarkably beautiful and effective process for curing defects in the carbon. This seems to us to be damning the plaintiff company with faint praise, for it leads to the belief that the filaments of the Edison-Swan lamps must be initially bad. Further the *Times* remarks:—"Its possession will obviously be of great advantage to the Edison-Swan Company until scientific ingenuity devises some other method of attaining the same end." Would it surprise our leading daily to know that this same end has been attained long ago by different means?

HEDGES'S PATENT DOUBLE-POLE SWITCH.

IN our issue of March 25th, 1887, we described several important improvements in Hedges's patent switches. Since the time in question a demand has arisen for a double-pole switch which shall with one movement break both positive and negative leads. Such a switch is required, and is used in connection with house-to-house lighting from central stations, and for this purpose is usually placed at the junction of the service mains with the house mains.



To meet this want the Globe Electrical and Engineering Company has designed the double-pole switch which we now illustrate. It consists in effect of two Hedges's patent single-pole switches of an improved pattern mounted on a rectangular enamelled slate base. The arms of the two single-pole switches are joined by means of a connecting rod of vulcanised fibre, on which the handle is fixed. B and B' are inclined planes over which the circular contact pieces, A, and A', ride when making and breaking contact. Owing to the construction of the vertical grinding pin, these contact pieces are prevented, after passing off the inclined planes, from falling to the level of the slate base, thus obviating the necessity for any non-conducting bearing surface. In order to guard against the possibility of the switch being left "half-on" or "half-off" it is provided with spiral steel springs, s and s', which also effect a rapid shut off and ensure its remaining in the "off" position. It may be noted that the positive and negative portions of the switch are kept an ample distance apart so that there can be no chance of short circuiting or leakage. Double-pole switches of this type are used extensively for the installations supplied both from the Kensington Court and Grosvenor Gallery stations.

NOTE ON THE GOVERNING OF ELECTRO-MOTORS.

By W. E. AYRTON and JOHN PERRY.*

IN 1882 a method was brought forward by us for governing electromotors, so that their speed should not be varied by an alteration in the load. The method, which was worked out theoretically and experimentally, was based on the combination of a motor, which converted electric energy into mechanical energy, with a brake dynamo, which reconverted the surplus mechanical energy into electric energy. After passing through various stages the arrangement finally resolved itself into an electromotor having the field magnet wound

with a shunt and a series coil, the coils being so connected with the rest of the circuit that the currents passed round them in opposite directions. Hence the magnetic excitation of the field magnet was produced by the difference in the number of ampere turns of the two circuits passing round it.

This method of governing motors, which has since 1882 been reinvented in France by M. Deprez, in America by Mr. Sprague, and which has formed the subject of an exhaustive series of experiments carried out in Germany by Dr. Fröhlich, answers well and produces a very fair constancy of speed for very considerable variations of the load. But it has a very decided defect, arising from the fact that since the series and shunt coils on the field magnet oppose one another's action, the magnetisation cannot be produced as economically as if there were no such differential action. Mainly on this account we have not developed our method of governing as energetically as we might otherwise have been led to do.

In our original investigation of the subject we considered the conditions for governing motors either when a constant P.D. (potential difference) or when a constant current was supplied, and in both cases the practical solution we arrived at was a differential winding of the field magnet. But we have since noticed that, in the case of the supply conditions being constant current, our original equations could be differently interpreted, and that the demagnetising series could be dispensed with. Consequently a motor for constant current can be made to go at a constant speed with a varying load, and in addition to have the high efficiency of a well-made dynamo.

We shall for the general consideration of the problem use the simplest equations for a motor, disregarding saturation, as we did in our original paper, since, although the results so obtained for critical speed, &c., cannot be used directly without correction in actual practice, these equations are sufficiently accurate to show whether or not a certain combination is a possible or an impossible one for obtaining a certain required result.

If E be the back E.M.F. in the armature of a motor at a speed of n revolutions, if p be a term depending on the permanent magnetism in the iron of the field magnet, s the current passing round the series coil, and z the current round the shunt coil, we have

$$E = n(p \pm qs \pm tz) \quad (1)$$

The signs + or - in the two terms being used as the series and the shunt currents respectively help or oppose the permanent magnetism.

If s and z be the resistances of the series and shunt coils respectively, A the resistance of the armature, and Λ the current round the armature, we have in the case of what has been called a short shunt (fig. 1),

$$E = Zz - \Lambda A, \quad (2)$$

and in the case of what has been called a long shunt (fig. 2),

$$E = Zz - \Lambda(a + s); \quad (3)$$

and in both cases, if C be the constant current supplied to the motor,

$$C = A + Z. \quad (4)$$

Now, remembering that in the case of a short shunt (fig. 1), C is equal to s , equations (1), (2), and (4) lead to

$$n\{p \pm qC \pm t(C - \Lambda)\} = (C - \Lambda)z - \Lambda A; \quad (5)$$

and in the case of a long shunt (fig. 2), remembering that C is equal to Λ , equations (1), (3), and (4) lead to

$$n\{p \pm qA \pm t(C - \Lambda)\} = (C - \Lambda)z - \Lambda(a + s) \quad (6)$$

Equations 5 and 6 have then to be satisfied for all values of Λ for constant values of n and C ; hence in the case of a short shunt,

$$\pm n(-tA) = -\Lambda(z + a), \quad (7)$$

and in the case of a long shunt

$$\pm n(q - t)A = -\Lambda(z + a + s) \quad (8)$$

* Read before the Physical Society on May 26th, 1888.

But t, q, z, a , and s are all positive quantities, and since t is always larger than q , that is the number of turns in the shunt coil is always larger than the number of turns in the series coil, it follows that to satisfy either equation (7) for the short shunt or equation (8) for the long shunt, the positive value of t in the original equation (1) can in either case alone be employed. In other words, whatever be the arrangement of the series coil, the shunt coil must be a *magnetising* and not a *demagnetising* one.

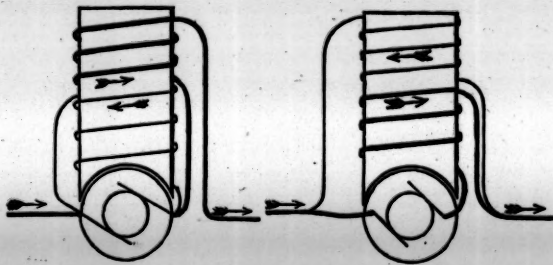


FIG. 1.

FIG. 2.

This result we pointed out in our original paper on "Electro-motors and their Government," in vol. xii. of the *Journal of the Society of Telegraph-Engineers and Electricians*, since on page 314 (or page 139 of the *ELECTRICAL REVIEW*, Vol. XIII., 1883), we stated that the solution for constant current was a shunt motor with a series demagnetising coil; and it would be unnecessary to refer to this point again were it not that in one of the standard English treatises in which our method of governing motors is described in detail, the only solution for constant current that we are credited with is the impossible one of a series motor with shunt demagnetising coil, the author not having observed that such a combination, whether used as a short or as a long shunt, could only make a motor run at a uniform speed when the speed was negative. Now, what does a negative value of n mean? It means that the armature must run the other way, or, in other words, that what was supposed to be a series motor must in reality be the armature combined with a series demagnetising coil, that is must act as a series brake dynamo, and the supposed shunt demagnetising coil must, in conjunction with the armature, act as a shunt motor; or, in other words, the solution is as we originally stated it—a shunt motor with series demagnetising coil.

In another important English work our method is given correctly, but it is stated that the method would not work, because when a greater load was put on the motor the armature would go more slowly, the back E.M.F. would therefore be diminished, and less current would pass round the shunt coil of the field-magnet. Hence the field-magnet would be weakened, which would cause the motor to go more slowly, and so on until it stopped and possibly reversed. This objection is a curious one, because exactly the same apparent difficulty might have been stated by the author of this treatise when he was dealing with our method of governing motors to run at a constant P.D. a few pages earlier. Here, however, he sees the explanation of the difficulty, and he points out quite correctly that, although it might at first sight appear anomalous to say that, in order to keep a motor running at a fixed speed, it is necessary to weaken the field of the motor when the load on it is increased, the explanation is found in the fact that the power depends not merely on the strength of the field but on the current passing through the armature, and that this latter is much increased when the field is weakened. Hence, on the whole, it is quite right to arrange matters so that the field is weakened when the load is increased. We say it is curious then, that while the author has explained the apparent difficulty so clearly when he was dealing with our method for governing motors when the supply condition was a constant P.D., he does not see that exactly the same explanation clears away the difficulty which he has himself raised regarding our method for

governing motors to run when supplied with constant current.

What, however, we particularly wish to point out in this short note is that when the condition of supply is constant current it is not necessary to have a series demagnetising coil at all, and consequently the motor can be made to run at constant speed independently of the load, and in addition to work with high efficiency.

We will first see whether such a solution is possible when the condition of supply is constant P.D. Let the motor be a simple shunt motor; then, if as before, E be the back E.M.F., n the speed, p a term depending on the permanent magnetism, and z the current round the shunt,

$$E = n(p + tz); \quad (9)$$

also

$$E = Zz - Aa,$$

if z be the resistance of the shunt coil, A the current in the armature, and a the resistance of the armature; also

$$V = \frac{Z}{s},$$

where V is the constant P.D. maintained at the terminal of the motor;

$$\therefore n \left(p + t \frac{V}{z} \right) = V - Aa \quad (10)$$

If n is to be constant as well as V , the left-hand side of the equation is constant, whereas the right-hand side varies with A , the current through the armature, which must alter as the power given out by the motor alters. One solution for making this equation always true, independent of the value of A , is the well-known one of making a very small. When, however, a is not very small, and we have shown in detail elsewhere why we consider it a mistake to make the resistance of the armature as small in a motor as in a dynamo, equation (10) cannot be fulfilled for constant values of n and V , and a variable value of A ; and in order that the equation may be made true, a negative term proportional to A must be introduced on the left-hand side. The simplest way of doing this is to add a series demagnetising coil. Then (9) becomes

$$E = n(p - qA + tz),$$

and (10)

$$n \left(p - qA + t \frac{V}{z} \right) = V - A(a + s),$$

an equation which will be always satisfied for any value of A if

$$n = \frac{a + s}{q}.$$

But when the supply is a constant current, C , supplied to the motor, the equation for a simple shunt-motor is

$$E = n(p + tz),$$

$$E = Zz - Aa,$$

$$C = A + z;$$

and, therefore,

$$n \{ p + t(C - A) \} = (C - A)z - Aa. \quad (11)$$

A now appears with a negative sign on both sides of the equation (11), and this equation will always be satisfied for any value of A if

$$n = \frac{z + a}{t}, \quad (12)$$

without there being any necessity for using a series demagnetising coil. At first sight, then, it appears as if an entirely new solution for governing a motor supplied with a constant current had been arrived at, consisting simply of using a shunt-motor. But on further examination it is seen that if we substitute in (11) the value given in (12) for n , we obtain for C the current for which the motor governs:

$$C = \frac{np}{z - nt}$$

$$= -\frac{np}{a}$$

But as this is negative it is necessary, in order that the shunt-motor may govern, that the terminals of the motor should be reversed. This will reverse the current round the field magnet; but, by hypothesis, not the residual magnetism, otherwise p would also become negative. The core of the electromagnet must, therefore, be of steel, so strongly magnetised that the shunt current does not reverse the polarity, and the permanent magnet and rotating armature together form a brake dynamo, while the shunt coil and the armature will form the motor. But this is simply one of the solutions (a theoretical one, of course, and not a practical one) given by us on page 310 of our original paper, or page 117 of the *ELECTRICAL REVIEW*, Vol. XIII., 1883, and illustrated in fig. 10 on that page.

The fact, however, still remains that in the case of the supply condition being constant current, equation (11) can be satisfied without the employment of a series demagnetising coil; and all that we have to do in order to make the solution a practical one, that is to enable an ordinary field magnet with soft iron core to be employed, is to alter the equation so that when the speed equation (12) is satisfied, (11) leads to a positive value of the current. This result may be obtained by adding to the right-hand side of equation (11) a positive constant term, e , numerically larger than np , for in that case, if

$$n = \frac{z + a}{t}$$

$$C = \frac{e - np}{a}$$

for all values of A . Now such a positive term, e , will be introduced on the right-hand side of equation e , if some accumulators of E.M.F. equal to e be introduced into the armature circuit, as in fig. 3, the accumulators

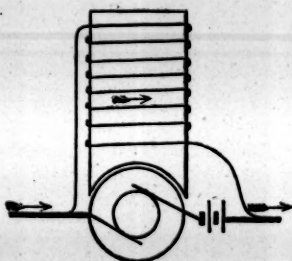


FIG. 3.

being joined up so as to help the main current, C . In that case, the resistance, a , of the armature must be increased by a' , the resistance of the accumulators; and the two equations we are finally led to for the speed at which the motor governs, and the constant current for which it governs, are

$$n = \frac{z + a + a'}{t}, \quad (13)$$

$$C = \frac{e - np}{a + a'}. \quad (14)$$

This solution is a practical one, and consists of a simple shunt-motor, with some accumulators in the armature circuit. Further, it is one not requiring many accumulators, for if np , the back E.M.F. of the motor due to the residual magnetism alone be small, as it will be if the field magnet iron core be soft, and further, if $a + a'$ be also not large, e need not be large in order that the value of C , the current for which the motor governs, may be as large as we like. The essence of this new method for making a motor supplied with a constant current revolve at a constant speed inde-

pendently of the load does not consist in combining a shunt-motor with a series brake-dynamo, which was the essence of our original method; but in combining a shunt-motor with a store of electric energy in the armature circuit, which store of energy, as the equations show, is automatically dealt out to help the motor exactly in proportion as the demand for power is required to keep the speed constant when the load on the motor is varied. And this store can be easily maintained by reversing the connections of the accumulators when they are disconnected from the motor, and the motor is at rest, and leaving the accumulators without supervision to be charged by the constant current that is continuously supplied to the station.

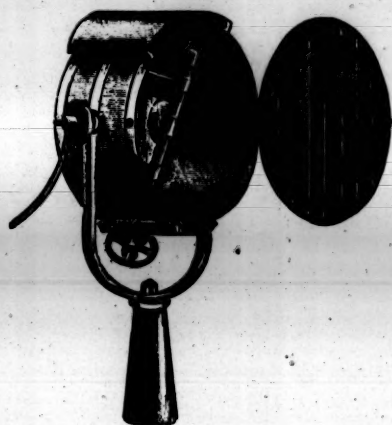
While on the subject of electromotors it may be well to point out a fact which we thought was well known—viz., that when motors are being tested one against another for efficiency and for power developed per pound weight, it is most important that the motors should each be supplied with the P.D. they are intended to work at and should be run at their normal speed. But we have been much astonished to find in the *Technology Quarterly* for September last, published by the Massachusetts Institute of Technology, a paper by Mr. H. Clifford on "The Efficiency of Small Electromotors," in which the results of experiments on the relative power and efficiency of a number of motors are given without any attention having been paid to the particular P.D. and speed at which each motor was wound to work at. Mr. Clifford's results are arranged in tables which would be of considerable practical value were it not that the essential condition for making such tests has been absolutely disregarded. Hence Mr. Clifford's tables are not only valueless but are most misleading. We are able to speak definitely on the subject, because the results of the tests made on a motor of ours, which are quoted, are made with the motor running at less than half its normal speed, and supplied with less than one quarter of its normal power. As well might incandescent lamps intended to be run with very different P.D.s. be compared when run with totally wrong P.D.s., and a 100-volt lamp condemned as useless because when supplied with only 50 volts it emitted but little light.

WALKER'S MARINE ELECTRIC LIGHTING PLANT.

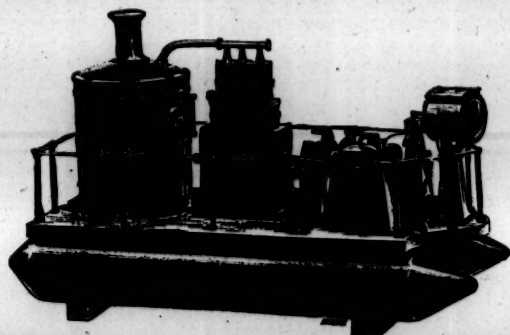
THE accompanying illustrations show a projector and a complete floating apparatus for the navigation of narrow waterways, such as the Suez Canal, by large vessels by the aid of the electric light. The projector is fitted with a metallic mirror of special construction, and the lamp may either be regulated by hand, or provided with mechanism for automatic feed and focussing; in both cases the stem of the lamp consists of a tube upon which the carbon holders slide, the mechanism being contained inside the tube and the hollow base. An angular adjustment of the upper carbon and the necessary movements of the barrel for directing the beam of light are of the simplest construction, and the whole apparatus is devised with a view to minimise the risk of injury by rough usage, clogging with dirt, &c., and at the same time economising space and weight. The floating apparatus consists of a projector of the foregoing type fixed upon a suitable pedestal at the forward end of a platform or deck, supported by two cigar-shaped pontoons. A vertical multitubular boiler and high speed engine coupled direct to the spindle of a suitable dynamo, serves to generate the current for the projector.

When it is desired to use the light the raft is floated into position under the stem of the vessel, and two guy ropes, attached to the barrels of two winches of special design upon the raft are passed upward, and made fast to both sides of the ship. These guy ropes being hauled taut by the winches, enables the raft to be drawn close to the stem, where the latter engages with

a suitable recess formed in the after part of the platform or deck. The raft may be aligned so as to interfere as little as possible with the steering of the ship. In the event of the vessel diverging from the marked course, the fact is made apparent to the operator in charge of the projector by the great deflection of the beam of light, and should the divergence be so great as to eventually cause the ship to take the bank, he may remove the raft from danger by releasing one of the



winches and hauling in the guy rope upon the barrel of the other, and may return the raft to its proper position when the ship is again straight on her course. A friction clutch allows the dynamo to be disconnected from the engine, and the power of the latter to be transferred to a screw propeller of fine pitch, thus enabling the raft to be propelled at a rate of from 4 to 5 miles



per hour when detached from the ship. The screw propeller is supported by an horizontal shaft between the pontoons, and a suitable rudder is shipped in the recess formed in the after part of the platform before referred to. A surface condenser is fitted inside one of the pontoons, and a small reservoir of fresh water in the other. The whole arrangement admits of the beam of light being kept out of the range of vision from the bridge of the steamer, and also may be used continuously for different vessels without rendering any special attachment to the ship necessary.

The projector and raft have been patented by Mr. Frederick Walker, and are manufactured by Messrs. Stephens, Smith and Co., of Millwall. A 10-inch projector of the above type, made by this firm is specially adapted for any purpose where a small search light is required, and may be used in connection with accumulators.

Electric Light in Turin.—We learn that Messrs. Bellain Brothers, have obtained a concession of 25 years for the electric lighting of Turin, where they have already installed more than 100 Thomson-Houston arc lights.

THE ARC WORKS, CHELMSFORD.

WE will now proceed to carry out the promise expressed in our "Notes" columns of last week, and give our impressions of the recent visit which we paid to the works of Messrs. Crompton & Co., of London and Chelmsford. Several years ago, on that memorable occasion when a number of the Dynamocables were entertained by the genial proprietors of the Arc Works, we briefly chronicled a similar inspection, but naturally things have changed considerably since then, and it goes without saying that Messrs. Crompton & Co. have kept themselves well abreast of the times in both mechanical and electrical engineering, and many are the improvements which have been introduced for the purpose of turning out the best possible machines at the lowest prices. Like most successful works, those of Messrs. Crompton & Co., which now cover three acres of ground, and on which have been erected buildings and appliances for 600 workmen, may be said to have grown from a small beginning. Their existence as electrical works is due to a visit paid by Mr. Crompton to Paris in 1878. It was there that he made the acquaintance of Mons. Gramme, and Mr. Crompton brought back with him to England a pair of the famous electrician's dynamo machines. He shortly after commenced the manufacture of these machines at his own works, and devoting his energies to the new industry, he constantly improved them until they arrived at the perfect state shown by the highly efficient dynamos now manufactured. Under the able guidance of Mr. Crompton, his partners and managers, the visitors on Thursday week were quickly taken through all the works departments, and everything of interest was briefly and clearly explained in such a manner that even the daily press men could have had no excuse for compiling that incomprehensible jargon of misunderstood terms which usually characterises their literary efforts when dealing with matters scientific. Dynamos of all sizes and variety and in all stages of manufacture were scattered about in profusion, the large armatures for such machines as Mr. J. E. H. Gordon proposes to use at the Whitehall Central Station, and the method of winding them, attracting much attention.

Here also might have been seen, quite recently, the largest armature hitherto constructed in the world for continuous current machines, but which is now at work at Milton supplying current for smelting aluminium direct from the ore by the Cowles process. This huge armature is in regular work, carrying a current of 5,000 amperes, and it is doing its duty very satisfactorily. At the time the largest armature shown was that belonging to a slow speed machine, for a new central station belonging to the Liverpool Electric Supply Company, capable of supplying a current for 5,000 lamps if driven at a speed of 720 revolutions. It is wound in accordance with a new patent of Messrs. Crompton and Swinburne. The armature has a clear passage through the centre, and admits of perfect ventilation, which had hitherto been considered impossible with this form of armature. Fourteen armatures of approximately the same dimensions as this one, have within the last twelve months been made in this department, besides a large number of smaller ones; in fact, Messrs. Crompton may be said to have hitherto had almost a monopoly of orders for this very large class of dynamos.

The machine, however, on which the most attention was concentrated was the alternating current dynamo devised by Messrs. Crompton and Swinburne, which is calculated to produce eight times the output, size for size, of a Westinghouse alternator. It is believed that it will give 2,000 volts and 32 amperes at 400 revolutions per minute without excessive heating. This dynamo was alluded to in an illustrated article on the subject of Messrs. Crompton and Swinburne's inventions in the REVIEW for Feb. 3rd, 1888, and it appears that a similar idea has already been tried in America, perhaps after the date of the English inventors' patents, with a result which seems to indicate that the sanguine anticipations

of the Chelmsford firm with respect to this machine will be realised in some marked degree if not in full. The following reproduction of a leaderette, which was published in our issue of August 19th, 1887, describes exactly the principle of the Crompton-Swinburne alternator, the only difference being that these gentlemen have provided a larger number of coils than Mr. Silvey, who only uses six:—"A Mr. Silvey invented, designed, or caused to be constructed, a certain dynamo. The magnets of this dynamo consisted of a cast iron ring with six projecting wedge-shaped pole pieces, the magnet coils being wound between these, and the whole thus forming a six-pole field with alternate N and S poles. If we read the description aright, the armature was a Paccinotti ring having six projections corresponding to the six pole pieces, and the coils were six in number, wound between these projections. The armature was of the open circuit class, and changed polarity six times per revolution, but when first tried it evinced great tendency to spark at the brushes. The startling part, which may be quite true and perfectly explicable, is as follows:—*To overcome this fault, after the armature was wound with its conductors, there were wound over it three layers of iron wire, each entirely encircling the armature, covering up the coils, and thus coming in direct contact with the poles on the armature. With this addition, simple as it may seem, the output of the machine was increased at least 70 per cent., and the sparking entirely overcome.*" That an American continuous current dynamo and an English alternator should have been built on precisely the same lines is, indeed, a remarkable coincidence, the novel point in both being the complete covering of the periphery surface of the armature with iron wire.

Another object of great interest was the application of electricity to the manipulation of gun training gear, a model of what the firm has successfully experimented with upon a 38-ton gun at Woolwich, being shown in operation. By a touch of the hand on a lever, the big gun can be moved through an horizontal angle of 80 degrees in 25 seconds, and elevated or depressed through its full vertical range in 12 seconds, and both motions can be effected simultaneously.

At the time of our visit the attention of Messrs. Crompton & Co. was being directed towards the construction of a crane, worked electrically, for an East End timber yard. The use of steam cranes for stacking purposes in these huge stores of inflammable material is, of course, attended with serious risk, and it is believed that the employment of electricity will be the means of considerably reducing the insurance premiums upon such premises. The motor which is to actuate the crane was shown in operation lifting and lowering weights, the speed of the armature and the direction of motion being regulated entirely by the hand displacement of the brushes. It may, perhaps, still be within the memory of our readers that Maxim's regulator shown here some eight or nine years ago also depended for the regulation of its speed upon the displacement of the brushes around the collector, but in his case this was done automatically.

In all the works departments the electrical transmission of power finds full scope for its development, the pattern shop machinery, the fans for creating a draught in the forges, the circular saws, and other plant being driven solely by the agency of electro-motors. A small compact projector was shown in action with a self-regulating and focussing lamp to produce the "search" light. So far as we could see there is nothing in this, which is based upon the well known brake gear of the Crompton arc lamp, to get out of order, and as it dispenses with the necessity of hand-regulation which is usual in search light operations of the present day, one would naturally have thought that the Admiralty would adopt it, to some extent at all events. The officials, however, who preside over the electrical department of our chief naval office appear to think self-regulation a retrograde movement, and they, therefore, leave Messrs. Crompton's projector severely alone.

An interesting example of the durability of a well

designed and properly constructed dynamo is afforded in the machine which is constantly used for supplying current for the various requirements of the works. This, we are informed, has been in operation for several years without costing anything for repairs, and to all appearance it is likely to still continue for some years to come in the same effective state, notwithstanding the severe and sudden strains to which it is oftentimes subjected. Here it is that the real efficiency of the dynamo from the user's point of view comes in as we have previously endeavoured to explain, and this is gradually beginning to make itself more and more apparent. As the slow going and plodding tortoise may win the race against fleet-footed "puss," so will a machine with a fair electrical efficiency and a mechanical construction which is proof against hard usage, serve the buyer to better advantage in the long run than a more efficient dynamo electrically speaking, which is mechanically weak.

It is now well known to those who had the privilege of listening to the recent papers read by Mr. Crompton before the Society of Telegraph Engineers and Electricians, and the Society of Arts, that he is an enthusiastic advocate for the employment of secondary batteries, although not many years ago he was one of their most bitter foes. The story of his conversion is a very interesting one, serving both to point a moral and adorn a tale. No surprise will therefore be caused when we state that Mr. Crompton has the most perfect faith in the Howell form of accumulator, which he has chosen to adopt. In connection with secondary battery operations large switchboards were shown for the large central station now being constructed near Whitehall Court. They are intended for distributing current sufficient for 20,000 lamps, and are for the purpose of combining four of the largest size dynamos in parallel with eight batteries of accumulators. The arrangements are such that the current can be either taken direct from the dynamos, or from the batteries alone, or from the dynamos and batteries coupled parallel. A great number of changes can be made in the connections. The peculiarities of the centre portion of the board are the eight sets of double ring contacts intended for varying the electric pressure in the mains; by means of a shaft and pinions any number of these can be worked simultaneously or separately, as is desired.

The wonderful utility of the steam hammer is taken full advantage of in Messrs. Crompton's works, not only for forging, but for stamping, with the assistance of steel dies, certain parts of the dynamos out of the hot metal, and all metal casting is carried on in the premises.

Altogether the Arc Works establishment, with its heavy engineering and fitting shops, its dynamo department, smithies, carpenters' and pattern shops, instrument rooms, testing department, and the various other attributes of an engineering firm, may be termed a model of its kind.

To make the manufacture and sale of dynamos, the installing of the electric light, and the other incidental manufactures carried on in electrical works a profitable undertaking, demands something more than the best of tools and competent workmen, as many of our readers probably know to their cost; and here, again, Messrs. Crompton & Co. appear to have been exceptionally blessed, inasmuch as their commercial acumen seems to be on a par with their scientific attainments. This is, perhaps, best evidenced by the fact that even during the last few years of depression in electric lighting business, the firm has always made satisfactory profits, which, during the past 12 months, have shown a considerable increase.

Now that the Electric Lighting Act Amendment Bill has received the Royal Assent and become the law of the land, we may expect to see a marked revival of projects for giving to everybody the benefits of electricity. The unfortunate Electric Lighting Act of 1882, with its stringent and illiberal conditions, undoubtedly tended to cripple the trade of household electric lighting in this country, but we have always held the opinion that other causes had quite as much to do with

the many disastrous failures which we have from time to time chronicled.

The question which now naturally arises is what will be the result of the new Act? The business of electric lighting during the last two or three years has been making steady progress, much more so than many persons are aware of. It may be said with confidence that no new building with any pretensions to size is erected, and no new steamer or war vessel is now launched without being fitted with the electric light, and many districts both in London and the provincial towns, are already supplied with the light, not only for shops, hotels and public buildings, but also for private houses. These facts show a satisfactory advance, and the new Amendment Act which confers upon the companies or contractors such improved terms will certainly give a great impetus to this important industry. We may, therefore, expect shortly to see fresh proposals for establishing central stations to supply the electric current, both for light and power, on a sound commercial basis, for it has been shown that the public will pay for the privilege of using it such a price as will leave a substantial profit to those who will undertake to supply it from central stations.

In the lighting of public buildings, both at home and abroad, in ship lighting, office and club lighting, and in factory and private house illumination, the Chelmsford firm occupies an enviable position, and it evidently recognises, from signs which have not escaped our notice, that the electric lighting movement is entering on the final and permanent stage of recognition as a commercial necessity.

It may readily be surmised that Messrs. Crompton and Co. intend leaving no stone unturned in the endeavour to keep themselves as much to the fore in the future as they have been in the past, and with the sound commercial knowledge and technical skill possessed by them and their able helpers in each department, combined with their well known integrity and honesty of purpose, there is every reason to believe that the Chelmsford firm will not only easily retain its position in the front rank of electrical engineering establishments, but lead the way, and reap the benefit, in many of the practical developments of electro-technics which the next few years must see fairly and profitably launched.

ELECTRIC LIGHTING AT THE BRUSSELS EXHIBITION.

ELECTRIC light is largely employed for the illumination of the buildings and grounds, but in the conception of the original scheme it does not appear that this very efficient aid to a successful exhibition was sufficiently considered and provided for. Hence although gas was extensively laid on it was found after the date at which the exhibition should have been opened to the public, that a very large increase would have to be made in the plant for electric lighting.

It is a matter of regret that complete arrangements for the electric lighting did not form part of the original programme of the committee, as they have thereby missed an opportunity of bringing together in one place a most interesting exhibit, showing the advances made by the several representative companies who have taken to Brussels examples of various forms and types of electrical apparatus, but which, owing to their being distributed in various parts of the exhibition where the public are least likely to find them out, receive very little notice, and the results of comparison are, to a great extent, lost.

The interior of the exhibition is principally lighted by arc and incandescence lamps supplied and maintained by Messrs. Thomson-Houston, Schukert and a Belgian company L'Electrique, working on the Brush system.

In the grounds the lighting is divided between M. Pieper and the Anglo-American Brush Electric Light Corporation, Limited.

Pieper's installation has been working some time to a partial extent, but owing to there being deficiency of

boiler power the total number of lamps installed have not been regularly in work.

The Anglo-American Brush Electric Light Corporation, Limited, has 58 lamps of 2,000 C.P. in operation every evening. These are distributed as follows:—10 in British section, 6 at the switchback railways, 6 on the high mast opposite the entrance from the Rue de la Loi, and 18 on independent masts all round the grounds. 18 lamps are set apart for the illumination of the arena which was originally intended for the performances in the Hippodrome. These, however, came to an abrupt termination, but the lamps are still in use and effect a very useful purpose, as they light up a large space which is the principal thoroughfare from the exhibition buildings to the grounds, and bring into relief one of the most beautiful architectural features of the exhibition, which has perhaps more to boast of in this respect than most exhibitions of late years.

The machinery employed by the Anglo-American Brush Electric Light Corporation for generating the electric current will be found in the British section, stand No. 97.

The boilers are fixed outside the building, but the engines and dynamos are under the roof with other exhibits, and may be inspected in operation at all hours.

AN IMPROVED MAGNETO CALL BELL.

WE have had submitted to our notice an improved magneto call bell for telephonic and other purposes, manufactured by the Telegraph Manufacturing Company, of Helsby. The general appearance and construction of the apparatus is similar to the well known American pattern although it is smaller in size. To a casual observer there might not appear to be much difference between the new and the old pattern, but a critical examination would reveal a great many improvements which a good mechanic would appreciate, and which must greatly add to the efficiency of the apparatus.

The most noticeable feature, perhaps, is in the arrangement of the driving wheel, which instead of having a bearing which consists of the boss of the wheel only, has a long tubular axle the full width of the frame. The driving axle, to which the handle is attached, passes through the tubular axle, and is also the full width of the frame. An inclined slot device causes this axle to move forward when rotated, and to press a contact spring which places the armature coils in circuit in the usual manner; the continuity of the circuit however, not being dependent on the axle bearings as in the old pattern. An adjusting screw enables the depth of the teeth of the driver and the armature pinion to be accurately adjusted, so that a practically noiseless and easy working can be obtained with great facility. The bearings it should also be mentioned, are of hard brass so that a minimum of wear takes place. Another feature is the hinging of the box front which is done at the top instead of the side, which is an advantage in several ways. Generally speaking we would state that there is an absence of that "rat trap" style of work which is sometimes characteristic of American manufacture.

THE CADOGAN COMPANY'S LIGHTING STATION.

THE problem of electric lighting from a central station has been worked out hitherto on several well known systems, each of which seems to possess some inherent defect which stands in the way of the attainment of perfection. Quite recently Mr. H. Edmunds has introduced a new method of distribution, which, for the first time in actual practice, was tried on Thursday last in connection with the central lighting station of the Cadogan Electric Light Company, the directors feeling confident that by adopting this system they will practically overcome the difficulties which have hitherto beset house-to-house lighting by electricity. Leaving

till a future occasion a description of Mr. Edmunds's apparatus, we will endeavour to give an idea of the excellent way in which provision has been made at this station for a large and constantly increasing demand for electric current. The premises of the company, formerly a builder's yard, consist of an office, entered from the street, and a building at the back 90 feet by 90 feet, specially constructed for the purpose of an electric lighting station, under the superintendence of the managing director of the company, Mr. John S. Sayer. It is everything that such an erection should be, roomy, light, lofty, and well ventilated. At present the plant consists of a fine pair of Babcock and Wilcox boilers with a feed water heater of improved construction, three 50 H.P. Armington and Sims engines, and three 500-lighter Leeds dynamos. Ample room, however, is provided for another pair of boilers and six more engines and dynamos, some of which are already in course of construction. There is also a battery of E.P.S. accumulators, storing sufficient current for the lighting of the premises and for exciting the field magnets of the dynamos.

The Babcock and Wilcox boiler is now generally preferred in connection with electric lighting operations on a large scale, and is therefore so well known that it is perhaps rather late in the day to give a description of it; but as we have been favoured with the following particulars, we give them for the benefit of any to whom they may be new.

The Babcock and Wilcox boiler consists of a plain cylinder boiler, serving as a steam and water reservoir, placed above and connected at each end with a nest of inclined heating tubes also filled with water. The rear and lower ends of these tubes are connected to a mud-drum at the point furthest removed from the fire. The heat is applied to one-half of the cylinder and all the tube surface.

The boiler-setting forms a furnace in which all the heating surfaces are enveloped by the hot products of combustion as they rise from the grates situated under the front and highest end of the tubes, passing at right angles across them three times and once under the whole length of the cylinder, before being discharged into the stack, at a greatly reduced temperature.

The greater portion of the heat is transferred to the water during the first passage of the gases across the tubes and while combustion is being completed in the triangular chamber under the cylinder, these being properly fire-box surfaces. The remaining heat is taken up during the second and third passes across the tubes, which act as economisers.

As the water inside the tubes becomes heated, a mingled stream of steam and water is discharged into the front end of the cylinder above, where the steam gradually separates from the water, the latter flowing to the rear end of the cylinder and down again into the tubes, making a rapid and continuous circulation of all the water in the boiler, keeping all parts at a uniform temperature, and avoiding strains from unequal expansion. This rapid circulation also serves to sweep away the steam bubbles from the heating surfaces as fast as formed, supplying their place with water, thus increasing the efficiency of the surface; it also serves to carry any sediment contained in the water into the mud-drum at the rear and lowest point in the boiler, from whence it can be blown out.

The following is the record of a test made at the Grosvenor Gallery electric central station on May 4th, 1887, with two Babcock and Wilcox boilers, fed by pumps through an exhaust heater. The test was commenced at 2.30 p.m. and continued until 10.30 p.m., and the fuel used was Nixon's best navigation steam coal.

Duration of test, 8 hours; average steam pressure, 115 lbs.; average temperature of water fed by pump, 200 degrees; coal fired, 5,824 lbs.; refuse, 224 lbs.; combustible, 5,600 lbs.; percentage of ashes, 3.9; total water evaporated, 70,000 lbs.; water evaporated per lb. of coal, actual conditions, feed water 200°, steam pressure 115 lbs, 12 lbs.; water evaporated per lb. of combustible, actual conditions, as above, 12½ lbs.; average temperature of flue gases, 400 degrees.

At the Grosvenor Gallery station there are four of

these boilers, aggregating 656 H.P., which have worked continually since their erection in December, 1886, generally at double their rated capacity, and further orders have been given by the same company, in connection with their Deptford installation, aggregating 6,000 H.P., which allowing for spare boilers, will run engines of 10,000 H.P. indicated.

It will be seen from these particulars that the Babcock and Wilcox boiler possesses in a marked degree the elements of safety, economy, durability, and accessibility.

The Armington and Sims engine has earned an excellent reputation, both in America and Great Britain, its leading characteristics being simplicity of construction, steadiness of power, and economy of steam. In form it is very compact, and is said to occupy a smaller space for a given power than any other engine. As long ago as 1883 the American Electric and Illuminating Company, of Boston, had 35 of these engines running, the president reporting that they were giving the most complete satisfaction. They were found to be "substantial and perfect in workmanship, economical in the amount of steam consumed, and ideally regular in speed, even under most trying and sudden changes of load." Since that date the English makers, Messrs. Greenwood and Batley, have supplied a number of these engines for electric lighting purposes, and are now introducing an improved form which is likely to meet with even increased favour.

The Leeds dynamo was illustrated and described in our issue of May 25th last. The machinery was started in the first week in February, and already seven miles of cables have been laid and a circuit of over five miles embraced, within which at least a dozen important installations have been started, the total number of lamps reaching nearly 1,000, while orders are already in hand for 2,000 more.

LIGHTNING.

By S. A. VARLEY.

ALL who have read the published lectures on the protection of buildings from lightning lately given by Professor Oliver Lodge, or who have had the advantage of hearing these lectures delivered, cannot fail to have been impressed with the scientific ability and deep learning Professor Lodge has brought to bear on so interesting a study.

Still these lectures seem to me to convey the impression that the behaviour of lightning is involved in great mystery, and they have a tendency, I consider, to unsettle men's minds by conveying an impression that lightning discharges instead of uniformly obeying certain defined laws as believed by Faraday and our older electricians, act irregularly and capriciously.

The feeling with which I rise from their perusal is that of an unsatisfied desire for more complete knowledge, and a wish that I could conveniently repeat Professor Lodge's interesting experiments, for there is an eloquence in the actual performance of an experiment which the fullest description ever fails to convey.

The subject of lightning discharges is one in which I have always taken an interest.

Many years since I devoted a great deal of time to studying its behaviour in relation to telegraph circuits. The first observation of real importance was made by me in Turkey, in 1856, when the lightning struck the Constantinople and Varna telegraph circuit.

The submarine portion of this telegraph was connected to Constantinople by about 24 miles of suspended wire, and there were three stations.

The terminal stations were at Constantinople and Varna, and the intermediate one was in the English Embassy Buildings at Therapia, about 11 or 12 miles from Constantinople, on the immediate shore of the Bosphorus.

The overground wire passed outside the grounds

attached to the Embassy, and the connection with the Embassy telegraph office was made by means of two lengths of submarine cable sheathed with galvanised wire buried in the grounds, and which formed a loop through the telegraph instrument. The total length of buried cable was about half a mile.

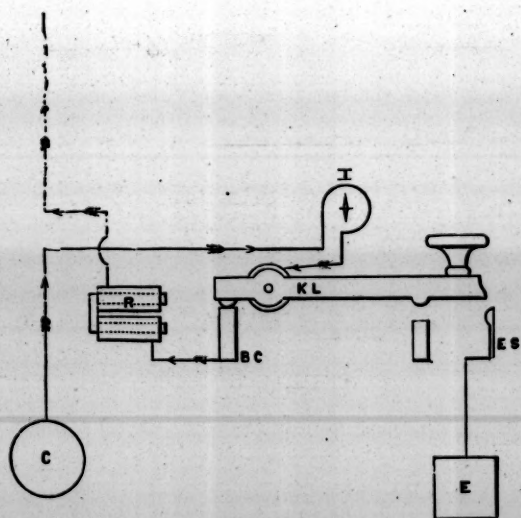
Now, as the Therapia station was an intermediate one, it may be suggested that there was no actual necessity for an earth connection there; but for reasons to be presently explained, there was an earth wire led into the office.

When I took over the charge of the circuit I found this earth connection had been made by means of the orthodox earth plate, and I found also it opposed considerable resistance. I therefore made a soldered connection between it and the galvanised iron wire sheathing of the two lengths of buried cable, thinking not unnaturally that a metallic conductor half a mile in length buried in the ground would make a very perfect connection.

The embassy grounds were situated on a subsoil of rock, still there was a surface soil of some depth, and the grounds were well timbered with numerous large trees.

When the hot weather arrived and the ground became, as a consequence, thoroughly parched, I found, to my surprise, the half-mile of buried cable made a very imperfect earth connection, and as the river was close at hand, I discarded it altogether and made another earth contact by burying a No. 8 galvanised wire under the esplanade of the Bosphorus and sinking a length of wire in the river.

Morse printing instruments worked on the single current system were used in connection with this circuit, and a current starting from Constantinople passed, as indicated by the arrows in the diagram, from the suspended wire through one length of buried cable, through the galvanometer indicator to the key lever, from the key lever through the back contact to the electromagnet of the relay, through this to the second length of buried cable, and from thence to the suspended wire again on the other side of the loop. The earth wire was connected to a vertical spring mounted on the key board near to the handle end of the key lever, which made a passing contact with it in its downward and upward motion; the effect of the passing contact was to discharge directly to earth the greater portion of the static charge acquired by the cable every time the battery was closed in the circuit.



earth; I, Indicator; R, relay; C, Constantinople; BC, back contact; S, earth spring; KL, key lever.

During a thunderstorm which occurred in the neighbourhood of Therapia, the lightning struck the overground wire and passed through one length of the buried cable to the galvanometer indicator, leaping across the convolutions of silk-covered wire, burning

them up, and bursting the indicator with a report as loud as a cannon, the current then passed on to the key lever which it lifted away from the back contact and depressed the front end of the key by electric attraction until it reached the earth contact, where it became fused and welded to the earth spring by the heavy discharge.

What I wish particularly to direct attention to is, 1. That this powerful discharge passed through one-quarter mile of gutta percha-covered wire buried in the earth without damaging it, showing how difficult it is under certain conditions to make a perfect connection with the body of the earth.

2. That although we know a lightning discharge to be instantaneous, the key lever was moved from a state of rest through a space of nearly one-quarter of an inch, and this movement *certainly* involved time.

I attributed the movement of the key lever to the magnetic polarisation of the line wire by the lightning.

In other words, the effect of the lightning discharge was to produce during a very small interval of time a very high state of magnetic potential in the line wire, and the rapid re-assumption of the normal unmagnetic condition which followed immediately afterwards developed a current of high enough potential to attract down the key lever, and of large enough quantity to melt and fuse together the key lever and earth spring. The current produced by the act of demagnetisation of the line wire was undoubtedly assisted by the static charge developed in a quarter mile length of buried gutta-percha wire, for although the resistance of the rock underneath the buried cable was so great that the lightning discharge did not burst through it and in this way reach the body of the earth, yet the large mass of semi-conducting matter surrounding the gutta-percha enabled it to receive a sudden charge, and as the iron wire sheathing outside the gutta-percha was a conductor of low resistance, the conditions were favourable for the rapid discharge of the electricity statically accumulated on the inner and outer surfaces of the gutta-percha insulator. The mass of earth and rock performed, in fact, a somewhat similar function to the slab of wood in some of Prof. Oliver Lodge's experiments, which acted the part of conductor so far as to permit of the accumulation of a positive and negative charge in the interior of two Leyden jars, the outer coatings of which rested on the slab, and yet at the same time opposed so great a resistance that when a sudden discharge occurred the electricity leaped a space of air instead of passing through the slab.

It should not be, however, overlooked that a No. 16 copper wire coated with gutta-percha (for this was the size of the copper conductor) and only a quarter of a mile in length when considered as a Leyden arrangement was one of very inconsiderable surface, but still I do not think it should be disregarded altogether, and I have a further reason for referring to it, which can be perhaps more fittingly considered a little further on.

On my return to England I experimentally investigated the subject, and the chief conclusions arrived at were described by me in a paper read before the meeting of the British Association at Liverpool in September, 1870. The following passages appear in this paper:—

"It was well known that high tension electricity would leap across a small space of air in preference to passing throughout the length of a coil of wire, and it was stated this arose from the momentary resistance the wire opposes to polarisation or magnetisation—a resistance probably approaching to infinite resistance during an infinitely small interval of time; and from this cause, even in a vacuum protector, where the pointed conductors are enclosed in an exhausted chamber, the main discharge will leap across a space of air separating the insulated conductor and the earth conductor outside the exhausted chamber, in preference to polarising the wires entering the exhausted chamber."

* This paper was published in *extenso* in *Engineer and Engineering* in October, 1870, and an abstract of it was published in the "Transactions of the British Association."

The author, when experimenting with electric currents of varying degrees of tension, observed the very great resistance which a loose mass of powder of conducting matter opposed to the passage of electricity of moderate tension; he found with a tension of 50 Daniell cells electricity did not pass through a loose mass of finely divided blacklead or wood charcoal. When the tension was increased to two or three hundred cells, the particles arranged themselves by electrical attraction, making good electrical contact, and formed a bridge by which the electricity freely passed. With a tension of six or seven hundred cells the electricity was found to pass through a considerable interval of the dust met with in rooms, which consists chiefly of silica and alumina, with more or less organic and earthy matters.

"Incandescent matter offers a very free passage to electricity; masses of highly heated blacklead powder were found with six cells to give an average resistance of 5 units, or about one-sixtieth of that opposed by an ordinary needle-telegraph coil, which may be taken at 300 units. These experiments went to show that an interval of dust separating two conductors opposes practically a decreasing resistance to an increasing tension, and led to the construction of the "lightning bridge," which consists of two pointed conductors, enclosed in a chamber, and approached to within one-eighth of an inch from one another, and surrounded with finely divided matter consisting of carbon and a non-conducting substance intimately mixed in suitable proportions determined by electrical tests. The reason why a powder consisting entirely of conducting matter cannot be safely employed is, that although it may oppose a practically infinite resistance to the passage of electricity of the tension of ordinary working currents, when a high tension discharge occurs, the particles under the influence of the discharge generally arrange themselves so closely as to make a conducting connection between the two points of the lightning bridge.

"If the effect of lightning striking the wires be considered, it will be seen that the electric discharge passing through the telegraph coils is not momentary, but occupies time. When an insulated telegraph wire is struck, the effect of the discharge is to polarise the wire throughout; after the discharge the wire returns to its normal unpolarised condition; but the cessation of magnetisation, although rapid, is not instantaneous, and the effect of the wire re-assuming its normal unmagnetic condition will be to develop an electric current flowing in the same direction as the electric discharge which magnetised the wire. The tension of the current developed by the demagnetisation will be very high at its first development, and will rapidly afterwards fall to zero. There is, therefore, first the main discharge of electricity, which passes by the shortest route, and does not wait to polarise the coil wires, but leaps across a space of air to the earth conductor as the easier course, followed by a secondary current in the same direction, but occupying time. The tension of this secondary current, although at first very high, is not nearly so great as the lightning discharge, and the greater portion, if not the whole, will pass through the coils, which oppose, when time is given, a much less resistance than the smallest possible space of air; it would, therefore, seem, when telegraph circuits protected by an ordinary protector are struck by lightning, it is to the secondary current, and not to the main discharge, the fusion must be attributed. The fact that the coils of needle telegraphs are more often fused than other telegraphic apparatus was considered to be a strong confirmation that the fusion was due to the secondary current developed by the demagnetisation.

"The relay coils used in other telegraph systems have soft iron cores which are rendered magnetic when a current is passed through the coils. A greater amount of magnetism is developed in these cores than in needle telegraph coils, but a very sensible time is occupied by the iron passing from the normal to a magnetised condition. The momentary resistance these cores oppose to magnetisation is very great; the demagnetisation of

the line-wire proceeds, therefore, more slowly; the electricity generated by the demagnetisation being of a definite amount, the tension of the secondary current is reduced proportionally.

"The line wire of a telegraph circuit is *only a continuation of the coil wires, and is rendered magnetic by electric polarisation in the same way as the coils*, the chief difference being that the magnetism developed in the coils is concentrated in a smaller space.

"When lightning strikes the line-wire of a circuit, in which electro-magnets protected by an ordinary protector are used, it magnetises the line-wire, leaps the space which separates the points of the protector, and *does not magnetise the electro-magnets*. Demagnetisation of the line-wire, which always takes time, and which can be retarded follows, and the resistance which the soft iron cores oppose to the assumption of magnetisation, retards the demagnetisation of the line-wire, reducing the tension of the secondary current. In needle-telegraph coils, there being no large mass of iron to be magnetised, demagnetisation of the line-wire follows much more, rapidly; the secondary current is more intense, and consequently needle-coils more often suffer."

(To be continued.)

THE CHELSEA ELECTRICITY SUPPLY COMPANY.

THE prospectus of the Chelsea Electricity Supply Company, Limited, has been issued, in which applications are required for 6,400 ordinary shares of £5 each, out of a total capital of £100,500. The company was founded in November, 1884, but its operations have been delayed, the interval having been utilised in securing the necessary Parliamentary powers, the site for the central station, and in canvassing the district to be lit.

That portion of the district first to be undertaken includes Lennox Gardens, Hans Place, Cadogan Square, Pont Street and other streets. The whole district seems to be a very likely one in which an electric light company can succeed.

Contracts have already been made with the Anglo-American Brush Electric Light Corporation, Limited, to supply and erect the boilers, engines, dynamos, &c.; with the Callender's Bitumen Telegraph and Waterproof Company, Limited, to manufacture and lay down all the necessary casings and conductors; and with the Electrical Power Storage Company, Limited, for the supply of accumulators, &c. These influential companies are closely identified with the whole scheme, and their confidence in the undertaking is shown by the fact that they each agree (at the option of the company) to accept half payment of their contracts (made on list prices) in ordinary shares of the company. The three contractor companies will also receive between them half of £500 founders' shares.

It may be here mentioned that the ordinary shares are to receive preferentially 6 per cent., and any amount earned beyond this is to be divided in the proportion of two-thirds to the ordinary shares and one-third to the founders' shares.

If the company is very successful, the holders of the founders' shares will be well rewarded, but not until the ordinary shareholders have their 6 per cent.

As directors, we have the names of the Right Hon. Lord Thurlow, F.R.S., chairman of the Anglo-American Brush Electric Light Corporation; Mr. J. Irving Courtenay, managing director of the Electrical Power Storage Company, Limited; Sir George R. Prescott, Bart., chairman of Callender's Bitumen, Telegraph, and Waterproof Company, Limited; and Major-General Webber, C.B.—all names well known in connection with the electric lighting industry; while Messrs. T. O. Callender, Frank King, and J. S. Raworth, all good men and true, will act as a committee of consultation to the company.

We shall hope to view in the near future the success

of this company, and there can be little doubt but that its prosperity will help to smooth the way for further business for all engaged in this now promising industry.

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY v.
HOLLAND AND OTHERS.
(Before Mr. JUSTICE KAY.)

(Continued from page 12.)

MR. JUSTICE KAY on Monday delivered judgment in this action. His lordship said: The plaintiffs sue the defendants for infringing two letters patent; one Edison's patent, No. 4,576 of November 10th, 1879; the other Cheesbrough's patent, No. 4,874 of 1878, amended by disclaimer dated the 12th of November, 1884. Both patents relate to electric incandescent lamps. The defence is taken up by third parties, the Anglo-American Brush Electric Light Corporation. The validity of both patents is put in issue. The first thing necessary is to ascertain as accurately as is possible to anyone who has not had the requisite scientific training, what was known on the subject at the date of these patents, say in 1879. There are two commonly known systems of electric lighting, the arc and the incandescent systems. These patents relate to the latter. The former depended upon a break in the conducting material occurring at a point where the conductor was carbon in the form of a pretty thick pencil. The current leaped over the break in an arc, gradually destroying the carbons; and this arc gave a vivid white light, especially at the positive pole. The incandescent system is different. The conducting material in this is continuous, without any break or actual interval; but, being in part an imperfect conductor, that part becomes heated by its resistance to what is called the passage of the current, and this heating, raised to an intense degree, gives the light now familiar to us in the incandescent lamp. The material which is now so heated is some form of carbon. It was well known that this was a good material for the purpose, because it was an imperfect conductor—in other words, had a high specific resistance—and that it was essential to use it in a vacuum or in some gas or vapour which did not contain oxygen, otherwise the carbon consumed quickly.

Until 1872, when Sprengel's air pump was improved by Mr. Crookes, it was difficult to obtain a vacuum which was complete enough. The consequence was, that it was necessary to employ a pencil of carbon of comparative thickness, because there was enough oxygen left within the exhausted glass bulb to occasion some consumption of the enclosed carbon, and also enough air to diminish the bulk of the carbon when incandescent by frictional action upon its heated surface, which Edison in his specification and some of the witnesses have called "air-washing." Another difficulty which prevented the use of very slender carbons was the irregularity of the current obtained from the dynamo. It was subject to variations, which at times produced a current stronger than the carbon could bear. This was remedied by the improvements of Gramme and Brush, which were perfected in the year 1878. Two modes of improving the resistance of the carbon were known, one by increasing its length, the other by the diminution of its thickness—or, to use the more exact language of the witnesses, of its sectional area. It was known that the carbon for an incandescent lamp must be enclosed in a glass bulb from which the air must be exhausted. Bulbs made entirely of glass had been used and publicly exhibited for this purpose. It was known that molten glass could be made to adhere closely to platinum wires, because the glass proper for the purpose expands with heat in the same degree as that metal, and that for this reason, and also because of its properties as a conductor of electricity, the best mode of connecting the carbon within the glass bulb with the main wires through which the current passed, was to unite each end of it to a thin platinum wire, and to fuse the glass round these wires so that air should not penetrate at the points at which they entered the bulb. It was known that by increasing the electromotive force the main wires bringing the electric current to the lamps might be reduced in size, just—to take the illustration given by Sir F. Bramwell—as by increasing the hydraulic pressure in the pipes supplying a town with water, you are enabled to use smaller pipes, because the water will pass with accelerated velocity. It was known that by using high resistance in the incandescent portion of the lamp smaller leading wires might be employed, and also a greater number of lamps might be illuminated from the same source of electricity by working them, as Dr. Hopkinson calls it, in multiple arc or in parallel. Two systems of using incandescent lamps were known, and it was recognised that when many lamps were to be lighted from one central station, and at some distance, the system called "multiple arc" or "in parallel" was best. That may be shortly described as a plan involving the use of one main leading and one return wire, each lamp being supplied with electric current by a smaller wire from the main leading wire, and returning such portion of the current as it took to the return wire, the main leading wire and the return wire being supposed to be parallel. The other system, which is little employed, was the use of lamps "in series."

In this case the whole current is sent through each lamp in succession, and accordingly lamps of comparatively low resistance are required.

The desideratum in 1879 was to obtain lamps of high resistance for the "multiple arc" system, which could be made "commercially," that is, in large quantities with reasonable cheapness, and, above all, that should have durability. Edison, Lane-Fox, Swan and others had been working with this object in the same direction. On December 19th, 1878, in a lecture given by Swan at Newcastle, he described an experiment on the production of light by passing a current of electricity from a dynamo through a slender rod of carbon inclosed in an exhausted globe. On January 17th, 1879, he lectured on the same subject at Sunderland, illustrating his lecture by experiments, exhibiting certain electric lamps. On February 4th, 1879, he again lectured at Newcastle, and he then exhibited the lamp which has been produced in evidence. It consists of a bulb made entirely of glass with leading platinum wires sealed into it, and connected with a pencil of carbon inside the bulb. This piece of carbon was obtained from Carré, of Paris, and was manufactured by him and shaped before being carbonised. It is $\frac{1}{16}$ th of an inch in diameter, that is considerably thicker than the carbons now used, and being straight, the leading wires are sealed into the bulb at opposite ends. This renders it liable to a defect which is alluded to in the correspondence between Swan and Mr. Stearn, viz., rupture of the carbon, or its separation from the wires by expansion and contraction under the great heat to which it is exposed. This lamp was exhibited again at Gateshead on the 13th of March, 1879, and seems to have been kept lighted for 10 to 20 minutes at a time on two or three occasions without injury. I have no evidence how long it would last if continuously used.

Swan, in the spring of 1879, ordered from Carré carbons in the shape of a hair pin, a model of which he produces. It is practically identical in form with some of the carbons now used in lamps, but with a larger sectional area. Lamps made with these would not have the defect to which I have alluded. He says that probably towards the end of 1879 he made some lamps with these hair pin carbons. They are referred to by Mr. Stearn in a letter dated the 26th of November, 1879, in which fig. 2 is a sketch of a lamp so mounted, but I do not lay much stress upon this as an anticipation of Edison's, for although Heaviside and other witnesses speak of having seen these lamps in 1879, I think the fair result of this evidence is that these were experiments which did not succeed in producing a commercially successful result before Edison's patent. On the 2nd of January, 1880, Swan obtained a patent for one of the most valuable inventions connected with the manufacture of incandescent lamps. That was for preparing the carbon by passing the electric current through it, and heating it to incandescence while the bulb was still connected with a Sprengel air pump in action. This is now always done, and the effect is to make the vacuum much more perfect, or, rather, less liable to be impaired by air or gas coming from the carbon itself when first heated in a vacuum. On the 21st of January, 1880, he obtained a patent for a horseshoe strip of cardboard prepared for an incandescent lamp by converting it into a substance like parchment by treatment with sulphuric acid and then carbonising. On the 27th of November, 1880, he obtained a further patent for the application of this process to cotton thread. This has proved a most valuable invention. It produces a non-structural tough material, said by one of the witnesses to be hard and stiff as a metallic wire, and this is now largely used for incandescent lamps. Mr. Edison applied to the object of producing a lamp of high resistance his untiring and apparently inexhaustible ingenuity, but his specification shows—as Sir F. Bramwell states—that he was not aware how much was actually then known to electricians like Lane Fox and Swan, and Edison conceived that he was the first inventor of some matters in which they seem to have anticipated him. Edison availed himself of the more perfect vacuum obtained by the Sprengel pump, and also of the known principle of increasing the resistance of the carbon by diminishing its sectional area, which had become possible to a much greater degree owing to the perfecting of the Sprengel air pump and the dynamo.

The most important point raised upon the construction of his patent of November 10th, 1879, is the extent of the second claim—whether it includes every lamp of the kind there described, the light giving carbon in which is a "filament," or whether it means only lamps with such filaments as are particularly mentioned in the body of the specification. Another point is upon the first claim—whether the word "lamp" in that claim does not mean merely the filament of carbon. A third question of construction is whether the carbonisation of the filament is to be effected before or after it is attached to the platinum wires.

With respect to the sufficiency of this specification it is urged that Edison ought to have defined exactly what was meant by the word "filament," and that his patent of 1879 is void for insufficiency of specification in this respect, and also because it does not give sufficient directions for carbonising filaments. None of the modes of making filaments particularly described, it is said, are practical; or, at any rate, some are not, especially the several modes of making filaments from a putty composed of lampblack and tar, and from that putty compounded or coated with various substances. Also, if the patent means that the filament is to be carbonised after being attached to the platinum wires, this, it is said, is impracticable, because the platinum wires would thereby be made porous and brittle, and could not be sealed into the glass so as to prevent air getting in at the point of sealing, or through the pores in the wire.

The proper mode of construing a specification, as laid down by Lord Wensleydale in "*Neilson v. Harford*," is to hold a fair hand between the patentee and the public willing to give the patentee on his part the reward of a valuable patent, but taking care to secure to the public on the other hand the benefit of that provision which is introduced into the patent for their advantage. This refers to the condition expressed in every patent, that the patentee shall particularly describe and ascertain the nature of his invention, and in what manner the same is to be performed. Lord Westbury's exposition of the rule of construction, taken from his judgment in "*Simpson v. Holliday*," in 13th *Weekly Reporter*, is somewhat more explicit:—"With respect to the rules that govern the construction of specifications," he says, "they are the ordinary rules for the interpretation of written instruments, having regard especially to the fact that the specification must clearly fulfil the obligation imposed upon the patentee by the proviso contained in all letters patent—namely, that the grant shall be void if the patentee shall not particularly describe the nature of his invention, and in what manner the same has to be performed. It is therefore made a settled rule that the specification must be so expressed as to be perfectly intelligible to a workman of ordinary knowledge, and it must follow that if there is any obscurity or ambiguity in the specification which is likely to mislead, this defect ought not to be helped by any refined or secondary interpretation of the language. It was contended before me, and the Vice-Chancellor is reported to have said that it has been settled by authority, that the most liberal construction is to be given to a patent that will sustain it, especially in those cases where the Court is satisfied that the invention is really new and useful. If the words 'most liberal construction' are intended to denote some particular principle of interpretation different from the ordinary rules for the construction of written instruments, I am not aware of any such authority. The Vice-Chancellor is made to say that this liberal construction is adopted in cases where the Court is satisfied that the invention is really new and useful. But novelty and utility are necessary for the validity of every patent. There is probably some inaccuracy in the note of the judgment." That case went to the House of Lords, and is reported in *Law Reports of House of Lords*, page 315. None of the learned lords in any way dissented from the passage which I have read. I take from the speech of Lord Chelmsford, then Lord Chancellor, the following passage:—"The construction of a specification, like other written documents, is for the Court. If the terms used require explanation, as being terms of art, or of scientific use, explanatory evidence must be given, and with its aid the Court proceeds to the office of construction." The particular decision in that case was that a description of a process for producing a purple colour from aniline by mixing it with dry arsenic acid, and allowing the mixture to stand for some time, or accelerating the operation by heating, was void, because it could not be done without heating, and that was described as an alternative process.

With regard to the construction of Edison's patent, No. 4,576, of 1879, I observe, first of all, that the provisional specification begins by stating the necessity that lamps connected in multiple should be employed without main wires of great size, and that it is essential that these lamps should have a high resistance. It is stated that this had been set forth in a previous patent of Edison's of the same year, and that lamps of great resistance had been obtained by a long wire of platinum or other metal pyro-insulated (which means coated with an incombustible substance) and coiled so that but small radiating surface was exposed. Then it is said that the present invention relates to lamps of a similar character, except that carbon threads or strips are used in place of metallic wire, and connected to platinum wires sealed into a bulb exhausted of air. A description of the mode of manufacture is then given, but not in so much detail as in the complete specification. Turning to that I find that it commences with a short statement that the object of the invention is to produce incandescent lamps of high resistance. Then follow four paragraphs stating in what the invention consists. The first of these is the coiling of carbon wire or sheets so as to offer great resistance and present but a slight surface for radiation. The next the placing of such light-giving body of great resistance in a nearly perfect vacuum. The third states that the connecting wires are platinum sealed into the glass. The fourth is the method of manufacturing carbon conductors of high resistance, and securing perfect contact between them and the wires. The specification next states Mr. Edison's view of what had been done up to that time. It is admitted that this is inaccurate in many respects. He appears to have been unaware of the attempts that had been made to do the very thing at which he was aiming—that is, to increase the resistance of the carbon burners in lamps made of bulbs of glass exhausted of air, the connecting wires being of platinum sealed into the glass. He seems ignorant that bulbs made entirely of glass had been used, or that they had been exhausted of air so as to form a vacuum. The statement is that theretofore the air has been replaced by gases that do not combine chemically with the carbon. The specification then proceeds to describe several modes of making the carbon burners. I find mentioned (1) cotton thread; (2) any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber; (3) such fibrous material rubbed with a plastic compound composed of lampblack and tar; (4) carbon filaments made by a combination of tar and lampblack; (5) sometimes a thread rolled in such compound; and (6) sometimes a compound with a volatile powder, such as powdered camphor or oxide of zinc, worked into it, in which case, he says, to make the light insensitive to variations of the current a considerable mass of matter should be used. The mode of connection is

stated to be moulding the lampblack and pure material round the platinum wires where they are joined to the carbon, and after carbonising them. The coiling is then described, and it is stated that the inventor has carbonised and used cotton and linen thread, wood splints, paper coiled in various ways, lampblack, plumbago, carbon in various forms, mixed with tar and kneaded, so that the same may be rolled out into wires of various lengths and diameters, each one uniform in size throughout. There are three drawings, two showing carbons very closely coiled, and one of them being within the bulb, and in each case there are clamps connecting the platinum wires cemented into the carbon with the wires sealed in the bulb. The other figure is of a straight piece of the substance which is to be coiled attached to platinum wires at each end, the figure and description of it in the specification showing that the coiling and carbonisation were to take place after such attachment.

Then come the claims, which are four in number, "(1) an electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance made as described and secured to metallic wires as set forth; (2) the combination of a carbon filament within a receiver made entirely of glass through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth; (3) a coiled carbon filament, or strip, arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light as set forth; (4) the method herein described of securing the platinum contact wires to the carbon filament and carbonising of the whole in a closed chamber, substantially as set forth." I do not agree that the word "lamp" in the first claim means only the "filament of carbon." The claim is, "an electric lamp for giving light by incandescence," which the filament alone could not do. The words "consisting of" are inapt, but the wording of the whole specification is exceedingly inaccurate, and this is only an example of such inaccuracy. "Containing" would have been a better word. I construe this claim to mean lamps such as described in which the distinguishing features are carbons of "high resistance made as described and secured to metallic wires as set forth."

This seems to me to make the meaning of the second claim more clear. Having in the first claimed lamps of carbon made as described, the inventor proceeds to claim all lamps with the combinations described in the second claim. There are (1), the carbon filament; (2), in a receiver made entirely of glass; (3), through which the leading wires pass; (4), and from which the air is exhausted. All these four things Edison, as is apparent from the early part of the specification, supposed that he had invented. I do not think that he intends to lay more stress on one than on another of them. In fact, the only one as to which it is possible to say there is any novelty was carbon in the condition of a filament. I take from Johnson's Dictionary the meaning of the word "a very slender thread."

The third claim relates to the coiling, on which great stress is laid in the provisional and complete specifications, and the fourth is a mode of attachment of the carbon to the wires.

The claims, as I read them, are—(2) a combination of four requisites for a lamp; (3) and (4) claims for two of those requisites separately; and (1) a claim for particular modes of making and attaching to platinum wires the first item of the combination—viz., the carbon filament. But claim (2) comprehends lamps containing carbon filaments, however made, and not only those made in the special modes described in the body of the specification and included in claim (1). The defendants construct incandescent lamps with all the four elements of the combination described in Edison's second claim. But the filament made by them is essentially different from anything particularly described in Edison's specification. According to the witness Sellon, the filament used by the defendants is made thus:—"Cotton wool is dissolved in chloride of zinc slightly heated; the result is a viscous, semi-liquid substance resembling in appearance a strong solution of gum arabic. This is boiled in the receiver of an air pump to extract all air. Then it is forced through a die with a small orifice by the pressure of a head of mercury, and the filament so formed is received in a vessel of alcohol, which solidifies it in the form of a thread. It is then left for a time in another vessel of alcohol, which dissolves all impurities and leaves it a non-structural thread of cellulose in an extremely pure condition. It is dried, carbonised, and fitted for use in a lamp. If Edison's patent claimed only lamps with filaments such as those particularly described in the body of the specification, it is obvious this would be no infringement. In 1879 Edison, so far as appeared, never dreamt of making a carbon filament in this way, but as I have come to the conclusion that Edison's second claim is wide enough to include any lamp with a carbon filament, however made, the defendants have clearly infringed this claim. Then comes the serious and important question whether so wide a claim can be supported. I have already pointed out that the only item of the combination which had any novelty was the use of the filament or "very slender thread" of carbon. Edison had managed to use carbons thinner than any one had used previously. The only advantage of a "filament" suggested in the specification is its high resistance by reason of its thinness or small sectional area. There was no invention described in this specification of any new principle. The principle of increasing resistance by diminishing the sectional area of the carbon was known and had been published by Lane-Fox and by Swan before November, 1879. Assuming that Edison had been the first successfully to put that principle in practice by the methods described in his specification, did that success entitle him to say, "No one shall make a lamp with a filament of carbon but myself"? Suppose the claim had been thus worded:—"I have

succeeded in making an electric lamp with a carbon burner—say, $\frac{1}{16}$ th of an inch in diameter—which gives a high resistance, and I claim a monopoly of all lamps with carbon burners, but thicker than that, however made.” Could such a claim be supported? That, in effect, is Edison’s second claim. One of the objections made is that the claim ought to have been worded in some such way as I have just suggested, in order to make it sufficiently definite. In other words, Edison ought to have indicated the exact boundary between his “filament” and such a Carré carbon as Swan had successfully used. From the drawings and from the great stress laid upon coiling the filament, the only object of which seems to be to increase resistance by using a considerable length, I should conclude that Mr. Edison did not conceive that extreme thinness of the carbon was practicable. Mr. Swan had tried paper, cardboard, and similar materials carbonised, and, if he had not tried a “filament,” he had used and obtained considerable success with Carré carbons not more than $\frac{1}{16}$ th of an inch in diameter. He was trying these in the form of a hair-pin, made and shaped to that form before carbonisation: and it seems impossible to say that Edison, by reducing the thickness of the horse-shoe carbon, had made any vast invention or contributed largely to the knowledge which such inventors as Swan and Lane-Fox already had on the subject.

There is authority for saying that if an inventor discovers some new principle and describes a practical mode of applying it, he may have a patent which would prevent another person from applying the same principle by different means. In “Jupe v. Pratt,” in 1st Webster, Baron Alderson says:—“You cannot take out a patent for a principle. You may take out a patent for a principle coupled with the mode of carrying the principle into effect, provided you have not only discovered the principle, but invented some mode of carrying it into effect. If you have done that then you are entitled to protect yourself from all other modes of carrying the same principle into effect, that being treated by the jury as piracy of your original invention.”

But is there any decision that an inventor who has discovered a mode of applying a known principle like this, of increasing resistance by diminishing the sectional area of the carbon burner, can obtain a monopoly of the principle? Sir F. Bramwell in his evidence for the plaintiff put the case in the strongest and most favourable manner by saying that Edison made the first commercially successful incandescent lamp. Unless that is so his claim to so large a monopoly would not, in my opinion, be arguable. I proceed to enquire—Did he make a commercially successful lamp—that is, were any of the modes of making lamps particularly described in the specification commercially successful? In most patent cases, when the validity of the patent is impeached for want of novelty, the most important witness is the inventor. It is usual to put him in the box and expose him to cross-examination. Mr. Edison is in America; but if there were any other reason which prevented his appearing as a witness at the trial, the court has power to direct an examination in America. He has neither been produced, nor has any attempt to examine him in America been made; and the objection was raised during the evidence to reading statements made by him in his later patents to show what he really had invented at and before the patent of his patent of 1879. I must say that this mode of conducting the plaintiff’s case seems to me to put the defendants at an unusual disadvantage; and I think the court is bound to prevent them from being prejudiced by it as far as possible. I shall not hesitate to refer to the language of Edison’s subsequent patents as admissions by him so far as they tell against the claim now made in his name to a large monopoly.

I have before me several patents by Edison in his own or other names. There are, amongst others, three in 1878—Nos. 4,226, 4,502, and 5,306; three in 1879—Nos. 2,402 and 4,576, which is the patent now in question; and subsequently in 1879, No. 5,127; in 1880, No. 3,765, which has been called in the argument, the bamboo filament patent; and in 1881, No. 539 and 1,918. Whenever he hit upon any improvement, Edison seems to have applied for an English patent without waiting to perfect the invention, and no one can read the patent in question of 1879 without being struck with the evidence of haste shown by the crude manner and imperfection of description in every part of it. In the later patent, No. 5,127 of 1879, Edison gives careful directions as to the mode of carbonising strips of Bristol board in moulds, preferably of wrought iron. In the bamboo patent, No. 3,765 of 1880, he begins by again asserting that the practice, so far as he knows, had been to make carbons of as low resistance as possible, and that he had discovered that the incandescent material should have the highest possible resistance in a very small bulk; and further, that carbons which are purely structural in character alone possess these qualities. By “purely structural” is meant a carbon wherein the natural structure, cellular or otherwise, of the original material is preserved unaltered—that is, it is not modified by any treatment which tends to fill up the cells or pores with unstructural carbon, or to increase its density or alter its resistance. One object of this invention, therefore, is to provide such carbons and means and method for their manufacture. He then mentions several kinds of vegetable fibre, among others the hard glossy exterior of the bamboo cane. Elaborate directions are given for shaping and carbonising these fibrous substances, and the claims include (1) an incandescent conductor formed of one or more carbonised natural fibres; (2) a slip or filament made of bast or fibre-like cane or bamboo; and (12) the method of forming them and then carbonising them. In all, there are in this patent 44 claims. To say that purely structural carbons alone possess the requisite quality was altogether an error. Swan’s unstructural carbons

parchmentised, as they are called, are among the best burners known.

The plaintiffs have been challenged again and again during the cross-examination of their witnesses to prove, if they can, that any lamp with a burner made according to the description in the body of the specification of November, 1879, has been brought into the market in England or in America. No evidence of this has been given, and I conclude that there was no commercial use of the invention of that kind. Until he had taken out his subsequent patents it seems that Edison did not introduce any lamp to the public. Dr. Hopkinson saw some, he says, probably in 1881, made under one of these later patents. In that year, 1881, Edison exhibited some at the Paris Exhibition in the month of September. These were bamboo filament lamps, and this was the first public exhibition of his lamps, at any rate in Europe. No doubt this is not conclusive that the invention had no utility, because, as it has been argued, improvements may have been invented so rapidly as to have superseded the original invention before it could be brought out publicly; but it is somewhat difficult to make out that lamps described in the specification of 1879 were commercially successful if none were ever brought into the market; and the success of a lamp made under a subsequent patent, like the bamboo lamp, which has been largely used, can hardly support a previous patent which did not describe it. It has been attempted to argue that the patent of 1879 did include the bamboo filament, first, because the second claim includes all filaments of carbon; and, secondly, because in the body of the specification Edison says, “I have carbonised and used wood splints.” I can only say I admire the courage of such an argument. The question is, whether the specification particularly describes a commercially successful lamp so as to support so wide a claim. This is not answered by saying that the claim is wide enough to include all filaments, and therefore they must be taken to be all described. And with respect to so much of the argument as rests upon the words “wood splints,” those words do not describe anything so as to show a workman how to make them. Indeed, they are not intended as a description, but occur in a sentence which may be properly called a passing observation, as though here, and in other parts of the specification, Edison was simply putting on paper a cursory allusion to experiments, how made, and whether successful or not he does not pause to say.

Filaments made according to the several descriptions in the specification have been made, carbonised and used by way of experiment in order to show that it was possible to make them. Upon this there was a considerable conflict of evidence. Mr. Crookes, the celebrated chemist, following the terms of the specification as he understood them, detailed experiments which he had made which failed completely, and declared that he was quite unable to make the carbons successfully from the instructions given. On the other hand, a young man named Gimingham, who had had some scientific education, was produced as a witness for the plaintiffs, and he deposed that he had, from the specification alone, without any special instruction, made the carbons successfully without difficulty. Other witnesses supported Mr. Crookes on the one side and Mr. Gimingham on the other. Some of the reasons for the success of one set of these experiments and the failure of the others were pretty clear, others I could not understand, and at my suggestion the parties agreed that the experiments should be repeated in the presence of Prof. Stokes, whom they chose as an independent expert, who should report the result to the Court. I have that report, which the parties have seen, and it is obvious from it that no one with the knowledge that existed in 1879, unless he were as practised as Mr. Edison himself or Mr. Swan, could have made a successful electric incandescent lamp from Edison’s description without a long series of careful experiments, and very many failures in his attempts.

With respect to the commercial success of the invention as tested by these experiments, I find from the report and a supplemental table of results which has been handed to me as an agreed statement that out of 100 lamps some broke down at once, 13 lasted less than 10 hours, 11 more less than 20, 18 more less than 40, and only six above 40 hours, of which four were unbroken at 60 hours, and of these four there is no further record. That is far from commercial success. No system of electric lighting could be maintained, except at an expense which could not practically be incurred, with lamps of such short life as these; and this explains most satisfactorily why Edison never sold lamps made according to the specification of 1879. In considering the sufficiency of this specification, it must be remembered that in 1879 there was no trade or business of manufacturing electric incandescent lamps. Lane-Fox, Edison, Swan, and other inventors had given much time and attention to the subject, but except such persons there were none who had any special knowledge in the matter. The dicta that may be found in some cases that the specification of certain patents must be read as addressed to adepts in the particular trade or business do not apply. For this reason it was essential that the specification should be carefully explicit. It ought to be such as would enable an intelligent working man to make an incandescent lamp without having to try experiments. Take, for example, the process of carbonising filaments. In his subsequent patents Edison gave elaborate directions for this. In this patent, though dealing with filaments made of putty compounded with lampblack and tar, cotton thread, thread coated with the putty, the putty combined with camphor or oxide of zinc, and other substances for the manufacturing of carbon filaments, he contents himself with saying that the cotton thread is to be properly carbonised; the fibrous vegetable substance is to leave a carbon residue after heating in a closed chamber, the tar

putty is to be carbonised in a closed chamber by subjecting it to a high heat. Nothing is said to indicate what sort of closed chamber, of what it is to be made, how it is to be used, the degree of heat to be applied, nor the length of time during which the heat is to be kept up. There is no mention of any packing to be used in the chamber, nor of any precaution to prevent distortion of the filament during carbonisation. There was no industry in 1879 in which carbonisation of anything so small as a filament was used. It was known to chemists that one mode of carbonising was to pack the substance to be carbonised in powdered charcoal, which, when heated, gradually combined with any oxygen which might be in, or might during the process find its way into, the vessel used, and thus the substance to be carbonised might be protected from being consumed. This mode of carbonising is mentioned in the patent of Pulvermacher, for making arc carbons, before 1879; but this certainly was not generally known, and it is not alluded to in Edison's patent, which is now in question. Carbonising filaments in an ordinary fire-clay crucible without such packing will not do. They are consumed, and nothing but ash remains. It seems that it can be done in an iron box with a lid carefully fitted, if the heat be gradually applied, and for a short time, but the carbons now used commercially are exposed to furnace heat, applied gradually at first, and kept up for periods of from 11 to 14 hours, and they are carefully packed in powdered charcoal, and wound on a frame contrived so as to yield as they contract. I have no reason to suppose that anything like that time, or so great a heat, could be successfully used with filaments in an iron box without packing. I am satisfied that considerable experiment would have been necessary in 1879 to discover what sort of closed vessel would do, whether packing was necessary, and what amount of heat, and for how long, and how it was to be applied. The specification seems to me altogether insufficient in these respects.

Then, as to the tar putty, it seems it may be made by kneading the materials with some exertion for an hour and a half. The only direction given is that it is to be kneaded until it assumes the consistency of thick putty. I have no reason to doubt that Mr. Crookes honestly tried to make it and failed. A workman would not have fared better, and could not have succeeded without much experiment. The filament, which is to have a volatile powder, like camphor, or oxide of zinc, worked into it, has been imitated by dusting a tar putty filament with these materials very carefully; but I do not think it has been done in the experiments as Edison intended. The description is vague; but I conclude from the mention of a volatile powder, that the object was to use something that would volatilise in the process of carbonising, and that a considerable mass or thickness of carbon was to be used which would be left by such volatilisation in a very porous condition, and would thus have its resistance increased. The experiments seem to me a mere pretence of carrying out this. No such carbon has been shown to be of any practical utility. Considerable evidence has been given to show that coating carbon with a non-conducting, non-carbonisable substance would cause its destruction when incandescent by decomposition of the coating, the oxygen in which, when free, would destroy the carbon filament. The evidence leaves it somewhat in doubt whether this occurs before an actual fracture of the carbon, occasioning the intense heat of an arc. I do not think it necessary to observe at length on other objections that were made to the specification. One of those related to the effect upon the plate wires of exposing them, together with the burner, to the process of carbonisation, which, as I have mentioned, the drawing fig. 2, and the description of it, show that Edison intended. Another is the use of the copper helix to assist in coiling the burner, another is the use of the coil of carbon which Edison describes, for the purpose of increasing the resistance by length without enlarging the radiating surface in proportion to the length of the burner. This seems to have been abandoned as useless.

My opinion is that the patent of Edison's, No. 4,576 of 1879 is invalid—first, because the second claim is for a monopoly of incandescent lamps containing a filament of carbon for a burner, which claim, I think, is far too wide, considering how little Edison had actually invented; secondly, because his specification does not describe a lamp which ever became, or, as I think, could have become, commercially successful; thirdly, because the directions therein contained are so insufficient that no one could have made the carbons he describes without considerable previous experiment; fourthly, because one of the processes described—viz., mixing the carbon with a volatile powder—I believe to be practically injurious if done as Edison directs; fifthly, because the coating with a non-conducting, non-carbonising substance, if not injurious, is of no practical utility; sixthly, because the same may be said of coiling the filaments, on which the patentee lays great stress. This patent of Mr. Edison's, No. 4,576 of 1879, has been the subject of litigation in a previous suit between the present plaintiffs and Messrs. Woodhouse and Rawson, who were manufacturing incandescent lamps and were sued by the plaintiffs for infringement. The case went to the Court of Appeal, and both in the Court of First Instance and in the Court of Appeal the patent was treated as valid, though apparently with some hesitation. I am bound by these decisions, and should follow them, of course, whether I agreed with them or not, if the evidence in the two cases were the same. But that is not so. On one point which Lord Justice Cotton seems to have thought essential the Courts were completely misled. They were given to understand that the carbon burner in the lamp exhibited by Swan before the date of Edison's patent was shaped after and not before

carbonisation. It is now admitted this was not the fact. It was a carbon made by Carré and used as made by him without alteration. But further, I am told that there was no evidence in that case as to the difficulty of making the carbons described in Edison's patent from the description in the specification. I understand that no contest took place as to the sufficiency or utility of any part of Edison's patent, and that nothing like the evidence as to the previous knowledge on the subject was given in that trial which has been adduced in this. With respect to the construction of the patent, the opinion which I have expressed agrees with that of the majority of the learned Judges in the Woodhouse and Rawson trial. The case has been brought before me with such an elaboration of evidence on every point that I think myself bound to act upon my own opinion, believing as I do that if the same materials had been before the learned Judges in the other case they would have arrived at the same conclusion as I have done. The other patent in question in this action is Cheesbrough's, No. 4,847 of 1878, amended by disclaimer dated November 12th, 1884. The specification describes and claims a method of preparing the illuminating portion of an electric lamp, and also a material for the manufacture of illuminating carbons. Shortly stated, the carbon to be prepared is surrounded with a carbon gas or liquid, and then heated intensely by the passage of the electric current. This causes a decomposition of the surrounding hydrocarbon and the deposit upon the heated surface of an extremely dense form of carbon, such deposit being in greater quantity upon the hotter—that is, the thinner—portions. The specification states that "carbon of the ordinary sort, when heated by the electric current, exhibits points and lines of unequal brilliancy. Carbons prepared by this process when so heated glow with a uniform brilliancy throughout." A French chemist, Despretz, in experimenting on the reduction and volatilisation of carbon, discovered that when the carbon was heated in an atmosphere of hydrocarbon this deposit occurred and interfered with his operations; and he describes this in a paper which was published in England some years before 1879. But Despretz did not utilise this product in any way, and his experiments had nothing to do with electric lighting. Assuming that Cheesbrough derived his knowledge of the mode of producing this material from Despretz's paper, his invention consists in applying it for the purpose of making uniform the light-giving power of a piece of carbon when heated by the electric current; and the beauty and merit of the invention consists in thus enabling an imperfect carbon, by a sort of automatic operation, to improve and perfect itself. I have no doubt that this is a good subject for a patent. I had more hesitation upon the claim for the material, which certainly was not discovered by him; but that is not the whole of the claim. It is for "a material for the manufacture of the illuminating conductors of electric lamps produced by electricity heating carbon in a carbon gas." That does not prevent anyone from making the same material and using it for other purposes. The claim is really for the use of the material for the burner of an electric lamp. This seems to me equally valid. Another objection—that pencils cut from the lime cylinder coated with carbon would not make effective carbons—seems to me to arise from a misconception of the specification. It is not the lime cylinder, but the deposit of carbon which is to be made into burners. The defendants have used this process of Cheesbrough's, but they say for a different purpose. Their object is to bring all their carbons to one standard of illuminating power, an operation for which they have invented a somewhat cacophonous word—"standardising." But Seldon, one of their principal witnesses, admitted that the process would cure any inequalities of light-giving surface in the particular carbon so treated. These, he says, in their cellulous carbon threads seldom occur. However, I cannot resist the conclusion that the defendants, by this use of the process for carbons of incandescent lamps, are infringing Cheesbrough's patent. The plaintiffs' reply in this case was, unfortunately, interrupted. The Attorney-General asked leave, if the Court wanted more assistance on any point, to add somewhat to the reply. I have not thought it right to trouble him further. Every point has been put again and again to the scientific witnesses. Twenty-one of the working days of the Court have been occupied by this case. I have not arrived at the conclusion I have intimated without thought and care, and I do not think that further argument would be a useful expenditure of public time. I must therefore decline to trouble counsel any more in the case. I have been provided with a copy of the print of the shorthand notes. They contain, as is, perhaps, inevitable in such a case, a considerable number of verbal inaccuracies, some of which completely distort the meaning of what was said. The action, so far as it relates to Edison's patent of 1879, must be dismissed with costs. There must be an injunction to prevent any further infringement of Cheesbrough's patent, and the defendants must pay the costs of the action so far as it relates to that. The costs must be set off in the usual way.

Sir HORACE DAVEY: It is necessary to ask your lordship under the Act, to certify that our objections were reasonable to propose.

Mr. JUSTICE KAY: As far as I remember them they were all reasonable.

Sir HORACE DAVEY: That will be sufficient. Perhaps your lordship will think this case is of sufficient importance to allow the costs on the higher scale? I think the words are "of sufficient importance and difficulty."

Mr. JUSTICE KAY: Yes.

Mr. BRENNER: I have to ask your lordship for a certificate.

Mr. JUSTICE KAY: You can take the certificate as to the Cheesbrough patent that the validity came into question. It was

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previously brought into question, I was told, and I think you are entitled to the costs as between solicitor and client.

Sir HORACE DAVEY: The Anglo-American Brush Company are third parties, but I think it will be more convenient, as no question was raised as to that, that they be put in direct relation with the plaintiffs, to which I suppose there will be no objection.

Mr. BERNIER: No, I think not.

Mr. ASTON: Would your lordship allow me to ask whether on the Edison patent your lordship would not be pleased to direct that we should have the costs of those issues on which we were successful.

Sir HORACE DAVEY: His lordship has not found you successful.

Mr. ASTON: There is the question of infringement.

Mr. JUSTICE KAY: I do not see how it is possible to infringe an invalid patent.

Mr. ASTON: I know that has been said more than once, but the question of infringement is a question of fact, which is separate, and your lordship dealt with it separately in your judgment.

Sir HORACE DAVEY: Are there any extra costs for infringement?

Mr. ASTON: Oh, yes; we were obliged to call witnesses upon it.

Mr. JUSTICE KAY: You did not give a fraction of evidence about infringement. It was all admitted by Mr. Sellon.

Mr. ASTON: We were obliged to be ready, at all events. Then there is that other issue, with regard to the alleged anticipation by the user of Swan's lamps. Your lordship was with us upon that.

Mr. JUSTICE KAY: I think it is very inconvenient to make any distinction in a case where it seems to me the plaintiffs have failed. I am not inclined to make any distinction.

Mr. ASTON said it was done in the *Badische Anilin* case, and the Court of Appeal held it to be a proper thing to do.

Mr. JUSTICE KAY: I do not think it right to do so. I think you ought to pay the costs of the action.

NOTES.

Bath and the Electric Light.—The report of the Electric Lighting Committee of the Bath Town Council says:—"All the persons tendering concur in recommending the adoption of overhead in preference to underground wires as being much less expensive and less liable to failure on account of defective insulation. There are three methods of fixing overhead wires (1) on poles placed on house roofs, (2) on brackets placed on house fronts, (3) on lamp posts in a line with the kerbstone placed from 100 to 150 feet apart. The last-mentioned is the method recommended." The following are the chief particulars of the different tenders:—

	System.	No. of lamps.	Price per lamp. Overhead wires.	Price per lamp. Underground wires.
H. G. Massingham, Bath	Thomson-Houston	70	£ s. d. 19 17 6	£ s. d. 25 17 6
Anglo-American Brush Corporation	Brush	67	...	...
C. Allen & Sons, Taunton	Thomson-Houston	66	25 0 0	29 10 0
	Brookie-Pell or Pilsen-Joel	66	21 0 0	25 10 0
J. Ravennes, London	Brush	40	26 0 0	30 0 0
Nicholson and Jennings, London	Brush	43	30 8 4	...
Newall and Co., Bristol	Thomson-Houston	68	25 0 0	29 0 0
	Brush	68	27 0 0	31 0 0
Laing, Wharton & Down, London	Thomson-Houston	75	24 0 0	28 0 0

The committee, having fully discussed the several tenders, gives it as its opinion that the one sent in by Mr. Massingham presents great advantages, and that the small extension of the area to be lighted with electric light which it suggests is well worthy the consideration of the Council.

Fire at an Electric Light Station.—The Boston station of the Edison Electric Light Company was burnt down recently. There appears to have been too much wood, covered with shellac varnish, in the building.

Electric Lighting Legislation.—An "Electric Lighting Order Confirmation Bill" was read a second time in the House of Lords on Monday.

Theatre Lighting at Toulouse.—An electric light installation has just been erected by the Toulouse Gas Company in the *Théâtre du Capitole* in that town. Current is supplied by two 500-light Breguet dynamos, each being driven by a two-cylinder Otto gas engine of 50 H.P. The dynamos and gas engines are placed in a cellar situated a short distance from the theatre. There are 1,000 lamps of 10, 16, and 20 C.P. installed, and they have been fitted to the existing gas fittings. The lamps are supplied from two circuits, which are so arranged that should an accident happen to one the lamps in the other will not be extinguished.

Leamington and the Electric Light.—In correspondence which has been taking place in a Birmingham daily paper, respecting the electric lighting at Leamington, Mr. Arthur Chamberlain claims that the terms of the contract between his firm and the Leamington Corporation have been fulfilled. They are only responsible, he says, for giving 183 times 16 candles for a definite number of hours every night in the year, and this they did. They offered to lend and fix on the clock tower of the Municipal Buildings four arc lamps, not because the present lighting is insufficient, but because it would be a striking additional illumination in an important centre. The Council had accepted the offer "in a form in which it was not made," altering the proposed height of the lamps from 100 feet to 30 feet, and otherwise varying the arrangement. The Council could try the experiment in the new form if it liked; but his firm declined to do it at their own expense, or to be responsible for it any way. He suggests that notice should be given to terminate the contracts with both the electric light and gas companies, and that pending the termination of the contracts the Council should receive and consider the report of the borough surveyor on the comparative candle-power of the two illuminants, and should also ask for fresh tenders from both companies, with the view of seeing what saving could be effected upon the present expenditure.

Lamps Out in Berlin.—Recently the electric lamps supplied from the station in the Friedrichstrasse, Berlin, went out simultaneously.

Electric Lighting in Australia.—The Hunter's Mill, New South Wales, Municipal Council has decided to light the borough with the electric light.

The Electric Light in Japan.—We learn that a central station for electric lighting, on the Gulcher system, will be shortly ready to commence operations in Yokohama.

Electric Light in the Tyrol.—The town of Innsbruck will shortly be illuminated by electricity. The firm of Ganz & Company, and the local gas company, undertake the work. The motive power is to be obtained from a fall of water, situated at about 8 kilometres from the town. Overhead wires will carry the current to transforming centres in the town, whence the distribution will be effected by underground lines. The installation will at first consist of 3,000 lamps. It is hoped that before long this number will be doubled.

Exeter and the Telephone.—We hear that the Post Office telephone exchange in Exeter is finally closed. The subscribers never exceeded a dozen, although the exchange was in operation some six or seven years. The Western Counties Company opened in June, 1887, and has now 32 subscribers.

Sunday Telephone Service.—We hear that the United Telephone Company has at length decided to keep its exchanges open on Sundays.

Van Rysselberghe System.—It would appear that Switzerland is not the only country which has experienced some disappointment with regard to the Van Rysselberghe system of simultaneous telegraphy and telephony. For the last two years this method has been experimented upon in Holland; the Dutch Government has now, in consequence of the want of success attending the attempts in this direction, determined to abandon the system, and have granted the Bell Company a concession for the construction and fitting of a direct telephone line between Amsterdam and Rotterdam.

Long-Distance Telephony.—The new telephone line between Paris and Marseilles, touching at Lyons, has been completed.

The Telephone at Vienna.—In consequence of the reduction of the yearly subscription to £8, the subscribers to the Vienna telephone exchange have increased from 900 to 1,200. The overhead telephone wires cannot be increased, and it will be necessary to effect all extensions of the system by underground lines. To meet this expenditure, the company is raising a new share capital of £16,000.

Direct Communication between Liverpool and Havre.—The announcement is made that arrangements are almost completed for the establishment of a direct line of telegraphic communication between Liverpool and Havre.

Australian Cables.—The Eastern Extension Telegraph Company notifies the restoration of telegraphic communication with Australia and New Zealand.

An Electrical Deep-Sea Sounding Instrument.—Last week a series of experiments took place in the neighbourhood of Oban, for the purpose of testing a new patent electrical sea-sounding apparatus, by Messrs. Cooper and Wigzell, London. For the purposes of the trial, the steam yacht *Chic*, belonging to Messrs. Ogilvie, of Barcaldine, was placed at the disposal of the inventors. Soundings of various depths were successfully taken in different parts of the bay, in the Sound of Kerrera, and between Kerrera and the shores of Mull. The greatest depth, 118 fathoms, was got between Baic Island and Loch Spelve. In each case the records corroborated the registered chart depths. The invention is described as consisting of a sounder, a heavy instrument having a water-tight cavity at the upper end, which contains mechanism actuated by the pressure of the water, and at the bottom end it is fitted with jaws. These jaws close suddenly when they reach the bottom; they thus secure a specimen and bring it up. The sounding wire is wound on a strong cast iron winch, through which the electric current passes. On the recording dial a pointer or hand moves as the sounder descends the water, and becomes stationary on its reaching the bottom, marking on graduated cardboard the exact depth of water.

International Association of Electricians.—A conference of the International Association of Electricians was held at Paris on the 5th inst. M. Desroziers read a paper on dynamo machine construction, M. Montaud one on the use of accumulators in a system of electric lighting, and M. Ducretet a third describing a new magneto "exploder" for firing blasts.

Tubes to Cross the Channel.—Once more, says the *Financial News*, suggestions are in the air for a postal tube between Dover and Calais, and this time in a more detailed form. The idea is to suspend two tubes of about a yard each in diameter by means of steel cables across the Channel, 40 yards above the level of the sea. The steel cables will be fixed to pillars at distances of about 800 yards, and in each tube a little railway will run, with cars capable of carrying 450 lbs. in weight. No parcel of greater weight than this will be taken, and the cost is estimated at the modest figure of £1,000,000. It is also proposed to run telegraph and telephone wires through these tubes.

Photography of Lightning.—Dr. Oliver Lodge writes to *Nature*: So much interest is being taken at the present time in obtaining photographs of lightning flashes, that perhaps some one would be willing to take the necessary trouble, and use a moving camera. A camera revolving or vibrating at any ordinary pace would probably give each single flash unaltered, but it might analyse multiple and complex flashes into their constituents. The eye is so easily deceived as to what is really happening in these sudden effects that very erroneous views may easily be formed, and indeed are in some quarters now prevalent. Whether it is better to make the camera revolve as a whole, or only the sensitive plate, or whether a revolving mirror should be used with a stationary camera, are questions for experience to decide. One good method, if not too troublesome in practice, would be to arrange a double camera, with component axes parallel, so as to photograph the same flash in both halves, but with the sensitive plate of one fixed, of the other rapidly revolving. Appearances really due to succession in time could be then easily distinguished, and might be capable of interpretation.

Expensive Gas.—A good deal of dissatisfaction has been occasioned at Kingsbridge, in Devonshire, owing to the high charges of the local gas company, and an opinion prevails that the town could be lighted better and more economically by means of oil. The lighting committee has, however, decided to advertise for tenders for lighting the town with gas or otherwise. There is thus a chance for the electric light.

The Bankruptcy Court.—Last week a meeting of the creditors of Luther Hanson, electrical engineer, Halifax, was held at the offices of the Official Receiver. The debtor's statement of affairs showed assets £1,724 17s. 4d., and liabilities £1,518 3s. 8d., a surplus of £206 13s. 8d. In this estimate, however, the works had been taken as a going concern. The debtor was made bankrupt, no offer of composition being made. Mr. James Duff, of Barum Top, was appointed trustee, with a committee of inspection.

A receiving order in the case of Emile H. M. Andreoli was made on May 29th, the debtor residing at Loughborough Park, and accounts have been furnished, showing total liabilities £4,919, of which £3,577 are unsecured, with assets nil. The following is taken from the Official Receiver's observations. The debtor states that he is a journalist and foreign correspondent, which profession he followed for many years previous to 1878, when, having a small capital, he started a weekly newspaper, called *The Paris Exhibition of 1878*, afterwards changed to *Industry*, and acted as editor thereof until August, 1882, the undertaking resulting in a loss. From 1882 to 1884 he was engaged in certain negotiations in connection with Italian railways, which also proved unsuccessful. The debtor further states that he has been engaged in electrical experiments, which he has conducted with borrowed moneys, and has taken out two patents, and that in 1886 he started a French paper (*L'Ingenieur Electricien*), which was published in Paris until January, 1887. Since the beginning of the present year he has been engaged in experiments in electric bleaching, from which valuable results are anticipated.

Lightning Conductors.—An instrument for registering when a lightning conductor has been struck by lightning has been invented by Messrs. Hoyer & Glahn, of Schönebeck. The instrument consists of a galvanometer, whose magnetised needle is pivoted on a horizontal axis. A soft iron core surrounded by a solenoid, arranged as a shunt between two points of the lightning conductor, is placed below the needle. On the core being excited, one of the ends of the magnet is attracted and remains attached, owing to its own permanent magnetism. It is hoped that the apparatus will not only indicate through which conductor a flash has passed, but will also show the direction.

An Electrical Section to the London Chamber of Commerce.—At the meeting which was convened to take place last Friday afternoon at Botolph House, Mr. R. E. Crompton in the chair, the following resolution was passed:—"That the members present form a provisional committee for the purpose of organising an electrical trade section, that meanwhile each of those gentlemen present use their best endeavours to induce their friends to join the section, and that a circular with the names of the provisional committee be issued to the trade, inviting them to attend a meeting on the 27th July for the purpose of electing a permanent committee to represent the section."

Shaw and Connolly's Conductors.—In our leading pages we have referred to the use of Indiarubber as an insulator for electrical conductors, and with that subject we connected the names of Messrs. Shaw and Connolly. The manufactures of this firm seem to be steadily gaining ground, and the following description of their 0 quality conductor may be of service. The composition of this is in the nature of what is known as Hooper's separator, and, as an extra precaution, the wire is first covered with Clark's patent felt, which is in reality two layers of fine carded cotton with a layer of pure unvulcanised Indiarubber between them. Then is wrapped a pure rubber tape, then Shaw and Connolly's special separator tape which acts as a trap for any free sulphur from the vulcanising process. Then comes a tape of pure thick Para rubber, and outside all the firm's special double proofed vulcanised tape. When exposed to a specially high temperature, the outer pure tape is vulcanised by absorption, the separator preventing any free sulphur from passing to the inner tape or to the pure rubber in Clark's felt. Thus the firm claims high insulation with no sulphur near the copper, and the power of resisting great extremes of heat and cold without deterioration.

"Dead" Wires.—Our contemporary, the *New York Electrical Engineer*, again calls attention to the risks consequent upon the enormous number of unused conductors, amounting, it is said, to thousands of miles, existing in New York. We are told that Mr. Wheeler, electrical engineer to the Board of Electrical Control, has already initiated a campaign against the dead wires.

Correspondence.—We are obliged to leave over several lengthy letters which arrived after our Correspondence columns had been closed up. These will appear next week.

Trouve's Auxanoscope.—This very ingenious apparatus, invented by M. Trouvé, is intended for use at lectures, scientific meetings, &c., where pictorial illustration is required. It obviates the necessity of prepared glass slides, and from its simplicity is almost certain to replace the magic lantern and kindred methods of demonstration. A full description of the apparatus appeared in *L'Electricien* of April 14th, 1888.

Cost of Electric Traction.—The following table is the results of calculations made by experts on the cost of horses, cables, and electric storage cars on the Fourth Avenue street car line, New York:—

	Electric.	Horse.	Cable.
Cost of cars	1	54	81
Motive power	1	1.45	1.06
Construction of roadway	1	.53	2.00
Depreciation and repairs	1	1.47	2.04
Operating expenses (including wages) 1	3.38	1.71	
Total	5	7.37	7.71
Average	1	1.47	1.55

For haulage in mines the reports are most encouraging. Mr. Schaefer, at a meeting of the Engineers' Club of Philadelphia, stated that the cost per ton-mile in the anthracite coal mines was as follows:—mules, 1.82 cents.; steam, .6 cent.; electric motors, .4 to .67 cent. Considering the very obvious advantages of electricity as compared with steam in mining work, the figures are strongly in favour of electricity for traction in mines.

New York Conduits.—It appears that the conduits provided by the Board of Electrical Control, humorously designated by the *Electrical Engineer* as the "politico-histrionico-legal subway commission," do not give much satisfaction, the arrangements made for house connections being apparently utterly defective.

Action of a Current of Air and of Illumination upon the Electric Strata which cover Conductive Bodies.—MM. E. Bichat and R. Blondlot have devised the following experiment: A plate and a grating, cut out of the same sheet of brass and well cleansed, are placed opposite to each other. A beam of electric light, obtained by employing a positive carbon containing an aluminium core is let fall upon the plate through the grating. The plate is connected to one of the pairs of quadrants of an electrometer, the other pair being connected with the grating and with the ground. On illumination, the plate takes a positive charge, the potential acquired being from 3 to 4 volts. If a current of air is then directed upon the plate, the deflection of the electrometer becomes six to seven times greater. A blast of air without the illumination has absolutely no effect.

Lightning Curiousities.—The Vicar of Midgham, Reading, writes: "On Friday last a man in my employment, who was grass-trimming in my garden with a hook, took shelter under an elm tree during a heavy shower of rain, and I myself was taking shelter in a greenhouse close by. I can testify that there was not at the time or near the time any lightning or thunder seen or heard. When under the tree the man was employing his time in sharpening his hook, and whilst in the act of so doing, or at the moment he had finished, he heard, as he describes it, a hissing noise, and in an instant he was knocked against the tree, the sleeve of his shirt (his coat was off) was slit from top to bottom; his arm, the hand of which held the hook, was rendered powerless; the hook itself was completely doubled up; and there was a hole in the brim of his felt hat about the size of a florin. He has since recovered the use of his arm. I write this letter in the hope that you may think fit to insert it for the purpose of warning workmen against holding their metal tools in their hands when taking shelter whilst thunderstorms are prevailing, even if there should be nothing to indicate that there is one in close proximity to themselves. It may also have the effect of eliciting the opinion of some man of science as to whether the fact that the man was sharpening the hook with a whetstone would at all account for the discharge of electric fluid."

During the prevalence of a terrific thunderstorm which passed over South Tipperary and Waterford, accompanied by vivid lightning, the telegraph clerk at Cahir railway station, a young man named Doyle, received a shock from the electrical discharge while standing near his instrument, which dashed him to the opposite side of the office, where he fell unconscious. He was removed in a critical condition.

At Murrow, near Peterboro', a signalman was signalling on the block instruments, when a flash of lightning struck the wires, burnt the instrument, and, striking the signalman's arm and hand, rendered them useless.

Early on Monday morning there was a heavy thunderstorm in the metropolis. It was of a very severe character in the South-Eastern districts. Shortly after one, a.m., the electrical apparatus in the fire-alarm post, erected in Wells-street, Camberwell, was struck by lightning, and the indicator at once commenced ringing in the watch-room at the Old Kent Road Fire Brigade Station. The men at once started with the engine and fire-escape—the storm being then at its height; but, of course, there was nothing for them to do except to return home.

Electric Bell Tenders.—Estimates are required for fitting up the Grand Atlantic Hotel, Weston-super-Mare, with electric bells. Application should be made to the architect (Mr. Wittington) for particulars, Grand Atlantic Hotel, Weston-super-Mare.

Incandescent Lamp Filaments.—We have already called attention to Messrs. Woodhouse and Rawson's latest carbons, which were exhibited at the Royal Society, and which looked more like black diamonds than anything else. We hear that they are making lamps with this carbon, which are of such a quality that the filaments do not require any flashing at all, and which they claim are a long way better than their old lamp, which had such a high character, and was so well known before the manufacture was stopped by the Edison-Swan Company. We learn that some tests of these lamps have been conducted for some considerable time past by one of the leading electrical companies, the lamps having an average efficiency of about 24 watts per candle, and that the length of life has surprised everyone. Should this be actually the case, the cost of electric lighting should be somewhat reduced.

Newspaper Enterprise.—The *Pall Mall Gazette* of yesterday contained a highly spiced article on the incandescent lamp patent case. Three gentlemen—Major Flood Page, Mr. E. Garcke and Mr. F. L. Rawson, were interviewed by the representative of our contemporary, but the results obtained do not appear to be equal to the energy which must have been expended in obtaining them. The first named still thinks that Edison was the first man to produce a practical lamp. Mr. Garcke considers that his company has gained a great victory, and that Mr. Justice Kay's decision will be of substantial advantage to the public, and Mr. Rawson claims that his lamp is 25 per cent. better than that of anybody else. This is the *Pall Mall Gazette's* article in a nutshell.

The East Strand and District Electric Light and Power Company, Limited.—This company has been formed for the purpose of supplying the electric light to the Arundel estate, and the surrounding district. A site for a central station has been secured in Arundel Street. The authorised capital of the company is £5,000, but with power to increase. The engineer to the company is Mr. J. G. Lorrain, M.S.T.E., and the secretary and manager, Mr. A. M. Lloyd. The registered office of the company is at 222, Strand, W.C., and further particulars are given in our list of new companies registered.

Overhead Wires.—At the last meeting of the Lewisham Board of Works, the Works Committee reported that it had considered the subject of telephone and telegraph wires referred to it, and recommended that notice be given to the company or persons who have fixed such wires in this district without the authority or consent of the Board, requiring them forthwith to remove the same. The recommendation was adopted.

The Opinions of Financial Papers.—With reference to our note last week, *re* Woodhouse & Rawson, Limited, we find the position to be exactly reverse to what was stated by us on the authority of the financial paper mentioned. The vendors' shares were valued by an expert as being worth par, but the directors took them in the balance-sheet at 15 per cent. discount, as this was the price at which some considerable number had changed hands. We find also that these sales were *bona fide* sales, and to some considerable amount. The supplementary report of the auditors was not kept back, but as it was rather long, it was mentioned in the prospectus that it could be seen. Woodhouse & Rawson, Limited, it seems, acted upon the advice of their solicitors and auditors, and with such names as Messrs. Linklater and Messrs. Spain Brothers, we do not think they were likely to go far wrong. There are many papers which lay themselves out merely for criticising companies, and no doubt the success of Messrs. Woodhouse & Rawson, Limited, which has been greatly commented on in the financial press, has provoked the attack which has been made without the authors making full enquiries.

Appointment.—We hear that Messrs. Woodhouse and Rawson, Limited, are forming a separate department, which will probably be turned into a limited company, for the application of electricity to tramways, light railways, &c., and generally for the transmission of power by means of electricity, and that Mr. A. Reckenzaun has been appointed as managing engineer. Mr. Reckenzaun has also accepted the position of manager to the Woodhouse and Rawson Electric Manufacturing Company, Limited, whose works are at Cadby Hall, as the health of the late manager, Mr. R. Archbould, has unfortunately given way. We must congratulate Messrs. Woodhouse and Rawson upon having obtained the services of such a man as Mr. Reckenzaun, who stands at the top of the tree in his particular line, and whose name is almost a household word, not only in this country but abroad.

NEW COMPANIES REGISTERED.

City of Westminster Electrical Syndicate, Limited.—Capital £10,000 in £1 shares. Objects:—To erect a central or other station or stations or other works, for creating, producing, generating, accumulating, distributing and supplying electricity for lighting, heating, signalling, telegraphic and other purposes in the City and Liberty of Westminster and elsewhere. Signatories:—Walter Gooden, 2, Victoria Mansions, 150 shares; Wm. Jackson, 20, Denbigh Road, W., 1 share; R. Wildenham, 116, Percival Road, Uxbridge Road, W.; H. J. Barnet, 6, Westminster Chambers, 10 shares; J. Troutbeck, 6, Westminster Chambers, 250 shares; C. Williams, 46, Huxley Street, Harrow Road, 1 share; F. Dicksee, 99, Camden Road, N.W. Directors' qualification, 10 shares; the company in general meeting will determine remuneration. Registered 11th inst. by Troutbeck and Barnes, 6, Westminster Chambers.

East Strand and District Electric Light and Power Company, Limited.—Capital £5,000 in £5 shares. Objects:—To apply for and obtain licences, provisional orders or Acts of Parliament for the supply of electricity. Signatories (with 1 share each): J. Dunn, F.R.I.B.A., 1, John Street, S.W.; C. E. Lloyd, 4, King's Beach Walk; A. W. Lightbody, 222, Strand; S. H. Burbury, 1, New Square, Lincoln's Inn; E. Wilson, 5, Adams Court, New Broad Street; A. M. Lloyd, Norfolk House, Victoria Embankment; J. G. Lorrain, M.S.T.E., M.I.M.E., Norfolk House, Norfolk Street, Strand. Registered 12th inst., without articles of association, by E. H. Cousens, clerk to the Law Land Company, Limited, 222, Strand.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

H. Dale and Company, Limited.—An agreement of 25th ult. (filed 5th inst.) provides for the purchase of the business of electricians and manufacturers of electric, photographic, and other scientific appliances, carried on by H. Dale & Co., at 26, Ludgate Hill. The purchase consideration is £7,000, payable as to £4,000 in eight debentures of £500 each, and 600 fully paid shares of £5 each.

Scientific Appliance Manufacturing Company, Limited.—An agreement of 25th ult. (filed 5th inst.) provides for the purchase of the business of electricians, &c., carried on by H. J. Dale & E. J. Dale, at 9, Kirby Street, Hatton Garden. The purchase consideration is £4,000, payable by the allotment of two debentures of £500 each, and 600 fully paid shares of £5 each.

LEGAL.

The United Telephone Company v. Tasker, Son and Company.—(Before Lords Justices Cotton, Fry and Lopes.)—This was an appeal against a decision of Mr. Justice Kay, reported in the REVIEW of July 6th.

The ATTORNEY-GENERAL (Sir R. E. Webster, Q.C.), Mr. ASTON, Q.C., and Mr. MICKLEM (with whom was Mr. MOULTON, Q.C.), for the plaintiffs, contended that the plaintiffs were entitled to an injunction in general terms; but said that they were willing to give the undertaking if limited to the 52 telephones.

Mr. INCE, Q.C., and Mr. W. R. BOUSFIELD, for the defendants, were content to accept the undertaking thus limited; but they said that the defendants never pretended that they had only 52 instruments in use—they had from 1,200 to 1,600 in use, and the plaintiffs had alleged that 200 of these were infringements of the patent. The defendants only intended to say that they had 52 infringing instruments in use, and they made that statement honestly, and did not discover until after the hearing of the motion that the other 44 telephones were also infringements, when they at once communicated with the plaintiffs.

The Court allowed the appeal.

LORD JUSTICE COTTON was satisfied that, though the undertaking was given in general terms, it was given upon the understanding of both parties that only 52 telephones which were infringements of the patent were in use by the defendants, to which 52 the undertaking and the injunction would apply. As soon as the blunder was discovered the defendants ought to have consented to a limitation of the undertaking to the 52 telephones, and his lordship thought that Mr. Justice Kay ought to have been satisfied on the evidence before him that the undertaking had been given by the plaintiffs as applying only to the 52 telephones, and he should have limited the undertaking accordingly. That, his lordship thought, was the undertaking which the plaintiffs intended to give. He did not say that the plaintiffs were bound to give any undertaking, but they were willing to do so, and they had a right to have the undertaking limited to that which they intended to give. With regard to costs the defendants had made a mistake as to the number of infringing instruments which they were using, and, as soon as they found it out, they ought to have acceded to the plaintiffs' desire that the undertaking should be limited to that which they intended to give, and ought not to have compelled the plaintiffs to apply to Mr. Justice Kay. The costs, therefore of that application and of the appeal must be the plaintiffs' in any event.

LORD JUSTICE FRY did not doubt that the misstatement of fact was a *bona fide* error on the part of the defendants, or that there was no intention to deceive. But when the error was discovered the defendants ought to have assented to confining the undertaking to the 52 instruments, which were in the mind of the plaintiffs when they agreed to give the undertaking.

LORD JUSTICE LOPES concurred.

which has just been terminated was forced upon your Corporation in defence of their rights, and to protect one of the most vital and important branches of their business.

The action was nominally brought by the Edison-Swan Company against Mr. William Holland, of the Albert Palace, who was using, and the Jablochhoff Electric Company, who had supplied a large number of the Corporation's lamps, and to whom the Corporation had given indemnities.

Upon the application of the defendants that the Anglo-American Brush Electric Light Corporation should take part in defending the action, opposition in the courts of law was raised by the Edison-Swan Company, thus endeavouring to preclude the Corporation from justly protecting their own interests by defending the attack made on their lamps; but an order of the Court was obtained enabling them to defend as third parties.

In consequence of the procedure of the Edison-Swan Company, your directors considered that it was necessary to protect your interests by demanding recognition of the Lane-Fox patents held by the Corporation, and they therefore commenced an action against the Edison-Swan Company for infringement of two of them. This action will come on in due course, and your directors, having acted upon the best technical and legal advice, await the result with every confidence.

After an exceptionally exhaustive trial, occupying 23 days, the action resulted on Monday last in a judgment in favour of the Corporation upon the main issue, viz., the Edison patent and in favour of the Edison-Swan Company upon the minor issue of the Cheesbrough patent.

The effect of this judgment is to invalidate the Edison patent, thus destroying the claim of the Edison-Swan Company to a monopoly for the "carbon filament."

The plaintiffs' Cheesbrough patent under which they claim a special method of preparing the "carbon filament" of incandescent lamps is upheld, and the Corporation (who have always contended that they did not employ the process for the object intended and patented by Sawyer-Man) were held to infringe this patent. This latter decision, however, in no way affects the Corporation's right to manufacture incandescent lamps, and they will continue without interruption to make "Victoria" lamps under their own patents, which are quite independent of any process which can be considered as falling within the scope now given to the Cheesbrough patent.

With regard to the costs, those incurred in respect of the Edison patent are to be borne by the Edison-Swan Company upon the higher scale, and those incurred in the minor issue of the Cheesbrough patent, which are relatively small, are to be borne by the Corporation.

It is quite possible that the Edison-Swan Company may appeal against Mr. Justice Kay's judgment, but your directors have not the slightest uneasiness as to the result.

By Order of the Board,

E. GARCKE, Manager and Secretary.

EDISON-SWAN COMPANY v. ANGLO-AMERICAN BRUSH CORPORATION, LIMITED.

The following manifesto has been issued to the shareholders of the Anglo-American Brush Electric Light Corporation, Limited:—

The directors have reason to congratulate the shareholders upon the result of the litigation with the Edison-Swan United Electric Light Company, Limited, and take this opportunity of putting before them the facts connected with this important case.

It is doubtless within the knowledge of many of the shareholders that the Edison-Swan Company about a year and a-half since obtained a judgment in their favour against the manufacturing firm of Woodhouse and Rawson upon two patents held by them, viz., that which was considered as the fundamental Edison patent for the general principles involved in the manufacture of incandescence lamps, No. 4,576, of 1879, and that of Sawyer and Man (known as the Cheesbrough patent), No. 4,879, of 1878, for a process in the manufacture of carbon for electric lamps. These actions were gained by the Edison-Swan Company in the Court of First Instance, before Mr. Justice Butt, and subsequently in the Court of Appeal.

Following these decisions the Edison-Swan Company commenced a system of intimidation against the users of the Victoria incandescent lamps, rendering it necessary for the Corporation to indemnify all purchasers or users against loss or damage, and to call upon the Edison-Swan Company to withdraw such notice, or to take such action as would justify their procedure.

At the same time, not wishing to involve the Corporation in the uncertainty of costly litigation in respect of patents which, as has been stated, had been upheld in the Courts, your directors offered to pay such a recognition royalty as should not be injurious either to the trade or to the interests of the public, provided that the Edison-Swan Company on their part would recognise, also by payment of a non-prohibitive royalty, the valuable patents of Mr. Lane-Fox, the property of the Corporation, which the Edison-Swan Company use in their manufacture.

These negotiations, which were initiated and conducted by your directors in the most friendly spirit, and which from every possible point of view were honourable and equitable to all concerned, were rejected, and the prolonged and costly litigation

CITY NOTES, REPORTS, MEETINGS, &c.

Maxim-Weston Electric Company, Limited.

YESTERDAY (Thursday) an extraordinary general meeting of this company was held at the Cannon Street Hotel, in compliance with a requisition from shareholders, "to appoint additional directors." There was general expectation of a passage of arms between the members of the committee appointed by the shareholders and Mr. Hugh Watt, M.P., should the latter attend. He did attend, and presided during the time that he remained in the room. It soon transpired, however, that the relations between them were to be, upon the face at any rate, of an amicable character. The names of five gentlemen, members of the committee, were submitted to form the addition to the board, and Mr. Watt asserted that he should urge no objection to any one of them. They were all large shareholders, and they would no doubt follow the course which was best in the interests of the shareholders. He still had as strong a faith as ever in the Maxim and Weston patents, to say nothing of the Watt, and if only a small proportion of the contracts they were now in treaty for were obtained, the company would soon be in a better position than it had ever yet occupied. The whole of the names submitted were accepted without demur, and the Maxim-Weston board now comprises, in addition to Mr. Hugh Watt and Mr. Lewis Swabey, Messrs. J. M. Klenck, G. H. Hildyard, W. D. Harvest, John Marks, and J. G. Couchman. Things had gone fairly well so far, but now a reverend gentleman who was understood to be a brother of Mr. Swabey, asked pointedly for an explanation from the chairman of his statement with regard to Mr. Brown's approval of Mr. George Howell's appointment to the board, a statement which Mr. Brown denied. There was an outcry against the raising of a matter of this kind. The committee and the new directors deprecated the discussion of personal matters publicly, and said that the new board might be relied upon to closely investigate anything relating to the shareholders' interests. The reverend gentleman persisted, however, and somewhat heatedly reflected upon the general conduct of the chairman in reference to the company. This was the prelude to proceedings of a very irregular character

Mr. Watt moved a vote of thanks to the committee, and when it had been accorded, notwithstanding that a great deal of talking was still going on, left the chair, and subsequently the room, amidst by no means pleasant remarks by shareholders whom he passed on his way, who invited him to answer the accusations which had been made against him. Mr. Newton, who seemed very indignant, and became more and more verbose and more and more excited as the meeting progressed, moved that Mr. Swabey should take the chair, and this was agreed to. A resolution was moved for the return to the members of the committee of the money they had expended in carrying out their investigations. This was held to be illegal, and the motion was modified into a recommendation, and in that form passed. This matter disposed of, but not without considerable discussion as to whether the sum recommended as the limit should be £50 or £100, the latter at length being agreed to. Mr. Swabey attempted to read a personal vindication of the accusations made against him by Mr. Watt, but the meeting was impatient, and Mr. Newton exclaimed that Mr. Swabey had had his vindication in a court of law. Mr. Swabey said he would be satisfied with an assurance from the meeting that he was "vindicated from those charges." A loud chorus of "Yes!" assured him that he was, and he dropped the subject. A Mr. Henderson, backed up by the Rev. Mr. Swabey, pressed a motion, notwithstanding the protests of the committee and the new directors, who argued that it would lead to the destruction of the company, that Mr. Watt's connection with the company should terminate forthwith. Mr. Swabey seemed undecided what to do. He asked, as a personal favour, that the motion should not be pressed, declared the meeting at an end, and afterwards was about to put an amendment which was proposed, but the confusion was so great that he could not do so. Somebody said that Mr. Watt had given the six months' notice required of him to terminate his engagement with the company, and the chairman was questioned as to the accuracy of the statement. Mr. Swabey replied that he could only say that Mr. Watt had told him so. He could see no record of it on the minutes. Mr. Klenck said Mr. Watt had told him in the presence of five others that he had sent in his resignation in May, so that his engagement would terminate in October; he was a member of Parliament, and they would pin him to his word of honour, if—but we had better not state the "if." The meeting broke up in confusion, and Mr. Newton remained for some while excitedly haranguing a group of shareholders who had gathered round him, endeavouring to explain to them why, although his feeling against Mr. Watt was as strong as that of anybody else, he thought it better policy, in the interests of the company, to refrain from entering into direct antagonism with him.

India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.

YESTERDAY (Thursday) the half-yearly meeting of this company was held at the Cannon Street Hotel, Mr. S. W. Silver, chairman of the company, presiding.

Mr. W. J. Tyler, the secretary, having read the notice convening the meeting.

The Chairman said the business was of a formal nature only; but before moving the motion to be submitted, he might state that the operations of the year thus far had been of a satisfactory character, so much so, that they looked forward to meeting the shareholders at the close of the year with accounts that would fully justify the dividend now proposed. He moved that an interim dividend of 5 per cent., or 10s. per share, free of income tax, be payable on and after the 20th inst.

Mr. Neil Bannatyne seconded the motion.

Mr. Webber asked whether the telegraph works were in full swing; whether the 120 miles of cable stated in the last report to be in hand had been disposed of; whether other employment was found for the vessels when they were not engaged in cable laying; why the Telegraph Construction and Maintenance Company could show a net profit of £88,798, whilst this company could only pay a dividend of £13,000; why, with £30,000 at their bankers, the directors told their coal merchants that they must take a four months' bill; and why the contract for the supply of coals was not put up to tender.

General Trevor enquired whether the accounts were sufficiently made up for the directors to be able to state whether or not the 5 per cent. now proposed had actually been earned, whether it was paid out of the profits of the half-year's working, or taken out of the reserve fund.

The Chairman, replying, said the telegraph department of their works was only partially employed; the 120 miles of cable was earning a good return; and they lost no opportunity of finding employment for their ships. As regards the accounts, their books were only made up once a year, and he could add nothing to what he had already said.

General Trevor: Then the directors are not able to say whether the 5 per cent. has been earned?

The Chairman: Well, yes. Our impression is that we have earned it.

Mr. M. Gray, the managing director, replying to the remarks of Mr. Webber respecting the coal supply, said no concern in London exercised more care in buying and testing coal. Tests were continually going on, and he saw the returns every week. Mr. Webber, who was himself a coal merchant, no doubt felt a little aggrieved because his repeated offers to supply the company had not been accepted. There was no favouritism in the matter, nor

would there be. It was incorrect that they gave bills; they always paid cash.

The motion was carried; and a vote of thanks to the directors brought the meeting to a close.

The Eastern Telegraph Company, Limited.

YESTERDAY (Thursday) the 32nd half-yearly ordinary general meeting of this company was held at Winchester House, 50, Old Broad Street, under the presidency of Sir John Pender, K.C.M.G., when the directors submitted the accounts and balance sheet for the six months ended March 31st, 1888. The report stated that the revenue for the period amounted to £359,706 0s. 8d., from which are deducted £87,184 10s. 8d. for the ordinary expenses and £38,412 5s. 6d. for expenditure relating to repairs, renewals, and laying of cables, &c., during the half-year. After providing £4,452 4s. 7d. for income tax, there remains a balance of £229,706 19s. 11d., to which is added £29,397 16s. 5d. brought from the preceding half-year, making a total available balance of £259,104 16s. 4d. From this balance there has been paid—Interest on Debentures and Debenture Stock, £20,835 14s. 7d.; Dividend on Preference Shares, £20,384 15s.; an Interim Dividend of 14 per cent. on the Ordinary Shares, £47,500; Total £97,720 7s. 7d. Leaving a balance of £161,384 8s. 9d. from which £275,000 has been carried to general reserve. The directors now recommend the declaration of a final dividend for the year ended March 31st 1888, of 2s. 6d. per share and a bonus of 2s. per share, amounting to £85,500, both payable on the 15th instant, making with the three previous payments on account, a total distribution of 12s. per share or 6 per cent. for the year on the ordinary shares. The balance of £884 8s. 9d. shown at the foot of the revenue account is proposed to be carried forward to the next half-year. The revenue includes £34,981 14s., dividend and interest for the half-year upon the company's investments in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies. The cables of all these companies are in good working order. The several sections of this company's cables are in good working order, with the exception of the Aden-Bombay duplicate cable, which is interrupted in shallow water about 18 miles from shore, and will be repaired without delay. With the object of providing a duplicate and alternative telegraphic service to the Cape, the Eastern and South African Telegraph Company (nearly all the shares of which belong to this Company) are making arrangements with the West African Telegraph Company under which the existing line of cables along the West Coast of Africa (now terminating at Loanda) will be continued to Port Nolloth and the Cape of Good Hope. The new cables will be worked by this company as part of the Eastern and South African Company's undertaking. The laying of these cables will secure the very important Cape service from the danger of interruption of the existing cables, and provide an alternative line to Aden and India, thus greatly strengthening this company's position both on the East and West Coast of Africa. The Chairman moved the adoption of the report and the declaration of the dividends recommended, and the motions were agreed to.

Anglo-American Telegraph Company, Limited.

THE report of the directors states that the total receipts from January 1st to June 30th, 1888, including the estimated balance of £2,344 18s. 4d. brought forward from the last account, are estimated at £77,579 18s. 8d. This amount, however, is subject to revision, dependent upon the result of the lawsuit still pending between this company and the Paris and New York Telegraph Company.

The traffic receipts show a decrease, as compared with the corresponding period of last year, of £19,635, the reasons for which are explained in paragraphs 6 and 7 of this report.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £42,180 6s.

One quarterly interim dividend of 5s. per cent. on the ordinary stock, and of 10s. per cent. on the preferred stock, was paid on May 1st, 1888, absorbing £17,500, and a second quarterly dividend of 5s. per cent. on the ordinary stock and 10s. per cent. on the preferred stock will be paid on August 1st, 1888, absorbing £17,500, leaving a balance of £390 12s. 8d. to be carried forward to the next account.

The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the St. Pierre-Duxbury cable, broken off Cape Sable, N.S., and of the Northern Placentia cable, near St. Pierre. The Island Cove cable, broken by an iceberg, was repaired by the officers of the station at Heart's Content.

The 1873, 1874, and 1880 cables are in good working order, but the interruption to the Brest-St. Pierre cable, announced in the last report, still continues; the ss. *Minia* is now engaged in effecting the repair, and as she has already made satisfactory progress, the directors have every reason to believe that communication by this cable will be restored before the close of the season.

The St. Pierre-Duxbury cable was again broken on May 28th at a distance of 200 knots from the latter place.

The company's system of cables and land lines in Newfoundland and Prince Edward Island is working satisfactorily.

The traffic passing over the lines of the Joint Purse Companies during the past half-year shows a considerable decrease as compared with the corresponding period in 1887. This decrease is explained principally by the fact that the Commercial Cable Company reduced their tariff from 1s. to 6d. per word on September

15th last, thereby entering into competition with the associated companies at equal rates.

The directors regret to report that the very encouraging increase of traffic, the principal part of which followed immediately upon the reduction to 6d. per word on May 5th, 1886, has not been continuous, and has now practically ceased, for, although Atlantic cable traffic is much larger than that carried to any other part of the world, it does not develop with sufficient rapidity to admit of the present tariff being made permanent.

The result of over two years' experience of the reduction of tariff from 1s. 8d. to 6d. per word has been an augmentation in the volume of traffic of about 140 per cent., and this fact proves beyond question that with the present system of coding messages, and with the large number of competing cables, exceptionally low rates upon such long and costly lines of communication cannot be made to pay.

The directors trust that arrangements will soon be made between all the companies for the establishment of more remunerative rates.

The attention of the public has been frequently drawn, through the Press, to the large amount of the company's capital, and this is alleged to be the sole reason why low rates cannot be made profitable upon the cables of this company.

The directors, in answer, would point to the fact that the margin between revenue and working expenses produced by the 6d. rate is too insignificant to show sufficient profit upon any amount of capital necessary, even at the prices of materials and labour now current, to relay or renew such a system of cables and land lines as that possessed by the company, without taking into consideration the absolute necessity of building up a substantial renewal fund, which is now admitted on all hands to be indispensable to the permanent existence of cable companies.

The appeal of the Paris and New York Telegraph Company, against the judgment of the Tribunal of Commerce, in favour of this company, came on for hearing on the 10th April.

The Court of Appeal decided that before final judgment could be given, reference must be made to the Conseil de Prefecture for the interpretation of certain administrative matters in connection with the concession of the Paris and New York Company. The directors fear that the final decision in the case will not be obtained for some months, as either of the parties to the suit has the option of appealing to the Conseil d'Etat, and which will probably be availed of.

The United River Plate Telephone Company.

The second annual ordinary general meeting of this company was held at Winchester House, 50, Old Broad Street, E.C., on Thursday, the 12th inst. The Right Hon. Lord Thurlow occupied the chair.

The Chairman said: It gives me great pleasure to have the opportunity of meeting the shareholders again, and to be able to meet you on very satisfactory conditions. You will remember when we last met neither the board nor the shareholders themselves could be considered to be quite free from anxiety either as to the present or the future. At that time I ventured to express the opinion that difficulties with which we were beset were of a transient character, as the result of the amalgamation of two hitherto rival companies. I think that what has happened since has happily proved the correctness of the forecast, and that so far at any rate all the statements that were made at the time when we last met were justified and substantial. I also expressed at that meeting—and I think this expression was fully shared by the shareholders—that we had the confidence of the company and the shareholders in the ability of Mr. Fels in carrying us through the amalgamation. That has been satisfactorily disposed of, and I think you will be glad I should take this opportunity of bearing some testimony to the ability and zeal and the energy and success which have attended Mr. Fels's administration. You will remember that his position has never been an easy one, and that during some period of the last 16 months it has been a period of anxiety and difficulty, but also a sort of satisfaction to us on looking back to reflect that notwithstanding these anxieties and difficulties when things were most adverse, we never failed to express our confidence in him, and promised him further aid and assistance if he required it; and so it seems under these circumstances, considering how we committed ourselves to the policy which was pursued, that we regarded the issue with the utmost satisfaction, and I think you will admit that if we had adopted a different course and taken any special restriction to these powers, we should have prejudiced our interests. But as a large number of our shareholders are intimate with the difficulties of amalgamating telephone companies, I think they will appreciate the difficulty of an amalgamation on so large a scale, when there are difficulties—some foreseen and some unforeseen—and when they have been met without personal jealousy and conflict, and I think what has been done has been done with a minimum of uncompromising results. I will say this much, that a vigorous and generous policy such as we have pursued up to the present time in giving our customers and subscribers the best service in our power, and placing in their possession the best instruments to secure the utmost sufficiency of their service, I am confident is the best way to make such a company succeed, and I also think that you will agree with me, that while we should exercise, as we have exercised, a due regard to economy in management, still, as occasion may require, it is not our duty to shrink sometimes from what we think heavy expenditure. In order to satisfy our customers in telephone administration, it is true, as it is true in

most things, and truer than it is in many things, that nothing succeeds like success. The greater number of subscribers you have, the firmer hold you have on them; if this is true in another place it is true in London, and wherever the telephone exists; but we have to deal with a country where the telephone is an essential element to the population, and where the telephone is ten times more used than it is in this country, and under these circumstances we feel sure this is absolutely necessary to satisfy a large body of the country; and if you satisfy them to a maximum rival schemes will be set aside. Then as to the development of our business, you were informed before that we have established an exchange at La Plata; we have established a small exchange at Corrientes, and entered into a comparatively provisional contract at Rosario. Rosario is remarkable for its rapid increase of population and wealth, and for its general spirit of enterprise which prevails in that city, and even to a greater extent in that prosperous country the River Plate. I do not propose to enter into particulars of this line, but I will say this much, that you may rely on it that the conditions of that agreement in themselves are of a highly favourable character to the shareholders of this company, and in addition to that it is difficult to exaggerate, in my opinion, the extent to which this purchase will consolidate our position and conciliate our customers. It is not necessary for me to trouble you now with any elaborate details as to our large capital expenditure during the last 15 months; it has been heavy and exceptional, but I shall be happy to answer any questions put to me as far as I am able to do so without jeopardising or imperilling any of the confidences entrusted to my care. But I may state one figure, which seems large to some. I want to say that we have recently erected at Buenos Ayres a multiple switchboard. It was erected by some of the most competent men. It is a very delicate and expensive instrument, and I believe this will favourably compare with anything of the kind that has been erected anywhere. The total cost of this is as near as may be £10,000. Now comparisons are sometimes useful, and it may be interesting for you to know that I have ascertained that one erected in New York cost upwards of £50,000. When one is dealing with items of such magnitude, it enables you to form some opinion as to whether our capital expenditure during last 16 months of organisation is far out of the way or not. Considering the large number of instruments of the two systems that we have had to renew, and with a great many duplicate lines, and considering what work we have done during the last 16 months, I do not think that our capital expenditure can be considered as anything extravagant, though I am bound to say it is unusual and not at all likely to recur. Of course, for that extension of our system further capital will be required from time to time, but not to the same extent, for the next 16 months. And now as to our profits. I think, considering all things, that figure which represents our true profits during the last 16 months may be considered very satisfactory, especially when you consider that we have had to write off the sum of over £10,000 (£10,775 19s.) for loss on exchange, leaving a net profit of £24,166 2s. 6d., out of which an interim dividend of 2½ per cent. has been declared. We have been enabled to put a considerable sum to what is practically a reserve fund. We have been able to do an unusual thing—to write off a considerable sum of the expenses. Of course, it is unsatisfactory that these figures represent a broken time of 16 months—that was unavoidable under the circumstances; in future we hope to render you the accounts in July, which will represent the year's expenditure and profits from 31st March of one year to the 31st March of another. Those dates may be unusual but we had no choice, but they suited the River Plate, and we have no inconvenience in keeping to them. I will not dwell any further on that point. Then as to one of the most important questions in the conduct of public companies, I mean the management and position of the board. You will remember how the original was selected; it was supposed to consist of seven members, three of each of the hitherto rival companies were to be nominees, three of one company and three of another, and these six were to elect an independent chairman, and they selected me because I was conversant to a considerable extent with telephones in this country and because they felt they could rely upon me to act with absolute impartiality in connection with the interest of the one company or the other. Now I desire to take this opportunity of stating that as regards the management of the company and the conduct of the meetings and business at the board meetings which we have held, that I have absolutely nothing to conceal from the shareholders. Our meetings have been of the most harmonious and friendly character. Of course it is impossible to discuss some matters of importance without differences of opinion, but during the 16 months that we have sat together we have had not to vote in the minority, but have come to an unanimous opinion. There is one other point I may refer to, and that is to express to my colleagues here in your presence my very hearty approval of the courtesy that I have received at your hands. I am happy to be nominee of the two companies—I am glad to represent them. I think it will be found that in nine cases out of ten, the prosperity of a company may very fairly be gauged and estimated as to its true value, by the extent of the confidence which you find amongst the shareholders. There is a feeling which is heartily shared by members of this board and has been felt from the commencement, that as opportunities occur it will be desirable in the selection of new directors to strengthen what is known as the River Plate Board. Well, that desire has never been absent from our minds for a single moment; not that your interests have suffered on that account, for we have had a board which has been intimate with, and had commercial interest in the River Plate. Mr. Jones had

hoped to have been here to-day, it is not his fault that he is not; he came over with the intention of remaining and attending this meeting and explaining his views as to future policy, but it was with great regret that he found himself compelled to return to America on urgent and private affairs 10 days ago, but he expects to be back in the course of two or three weeks. Well, Mr. Jones during the 16 months has spent nearly the half of that time in this country, and it so happens that during the time that he has been absent we have had the advantage of our local adviser, Mr. Courtenay. He is a man of the utmost energy, of the utmost discretion, and calm and sound judgment; he has been a member of our board and assisted in the deliberations all the winter and spring, and we have all derived great advantage from the personal contact we have had with him. He has been received by the River Plate Company, and is carrying on business there. Mr. Bateman sought an interview with me to explain that other and growing interests absorbed so much of his time, that he felt reluctantly compelled to sever his connection with the board. Still, I am desired to say that during the 16 months that Mr. Bateman has been one of our colleagues he has been a very useful member as he does not mind spending hours in examining into details in the accounts. He resigns because he has not the time that he once had at his disposal. Our desire to do the utmost justice to the large interests entrusted to us is so great, and we have such a feeling of growing responsibility in the large development in our business, that we desire to come before you now and to ask you to sanction the appointment of even two further directors. Our board at present consists of seven members which was the original standard laid down. We ask you, therefore, to allow us to increase this number and to reduce it as opportunities, certainly to seven again and nine including the directors in the River Plate. I feel sure that none of you for a single moment weigh in the balance an additional expense that you may be put to in the future. For this reason and on this account I am not sure at present that you will be put to any additional expense; that can only be decided by what may occur in the future. I ask you in adopting this report and balance sheet, to sanction at the same time two additional directors. The first is Mr. George Cooper, a distinguished engineer, the second a commercial gentleman of very great and successful experience in the River Plate business, M. Alfred Le Rossignol. They have been selected by us and by our most trusted adviser. M. Le Rossignol is also connected with railways and other local interests in the River Plate. Well, I do not know that I need further trespass on your time now, but I felt it my duty to say what I have done, and I feel now at liberty to answer any question put by the shareholders, reserving to myself the right of not disclosing to the public any particulars or details of matters entrusted to me which may prejudice the company in any way. With that single reservation I am at your disposal. I therefore beg to move that the report and accounts submitted to the meeting be hereby adopted and received.

Mr. T. J. Lawrence said he would like to know if they had actually handed over the net profit of £24,166 2s. 6d., a balance of the sum of £10,775 19s. for loss on exchange.

Mr. Fitzgerald: I do not think there are many who know the difficulties the company has gone through since its commencement. I know that the forming of these two companies is no light task, I do not think that in the telephone world such an amount of exertion has been expended before, at least, not to my knowledge. I must confess that Mr. Bateman is an extremely able man. I am not quite sure as to how many directors the articles of association admit, but I think they will admit as many as nine. Is there any reason why the entire number of the directors should not be elected? You remark that you were inclined to elect a gentleman who felt inclined to withdraw, but is there any particular reason why other directors should have to withdraw so speedily to make room for others. I put it to you whether it would not be advisable to have a board of nine instead of seven.

The Chairman: Mr. Lawrence asked two or three questions which he was perfectly justified in asking, and which are very easily answered. As regards the sundry creditors—that represents the sundry expenses in March, but paid in April, also some subscriptions paid in advance; that also means that a great deal of the subscriptions are sometimes paid in advance, and sometimes in arrear. Then, as regards debtors, this represents all goods sold. Out-standing subscriptions are a much smaller figure than they were several months ago. Some of the public out there have the law in their own hands: if you do not satisfy them they do not pay for a long time, and if you do not satisfy them at all, they do not pay you at all, and therefore you must satisfy them before you get their money. If you proceed to litigations they are so very prolonged and arduous that you are almost tempted to think that the local authorities would not be likely to bring a debtor to book, and, therefore, we have sometimes to take the instruments out of their houses. There are, however, often a considerable amount of out-standing subscriptions, but rationally speaking there is only half of what there was some months ago. A considerable amount has been written off as bad debts already. Then, as regards the loss on our exchange, I understand Mr. Lawrence to inquire whether that £10,000 was a mistake as a matter of book-keeping, or whether the money had been received and written off. I say it has been received and written off. As regards the cash at the bank, a natural question to ask is "How are we going to pay this dividend?" You must recollect that this was at our bank on the 31st of March; but I am thankful to say that we have all the money in the bank, and

something to spare. The only point we have to guarantee is that we believe the whole of this large sum of money as a profit earned, namely £24,942 1s. 6d., has been fairly earned and paid. I think Mr. Lawrence may make his mind easy on those points. Mr. Baker called attention to Mr. Bateman. I have expressed my opinion as to that. I have no more to say, excepting that I have expressed my appreciation of his services, and I hope some day to see him back. I cannot say any more as to Mr. Bateman. Then Mr. Fitzgerald alluded to the same point, and I sympathise with what he said, and I think there is some consistency in what he suggests in raising the number of the board to nine, but at the present moment we will ask you to sanction to fix the board temporarily at nine. Then, gentlemen, I will put the resolution that the report and balance sheet be adopted. This was seconded and carried unanimously.

Messrs. J. Courtenay and John Coghlan were elected directors, and Messrs. Cooper Brothers and Company were re-elected auditors, the meeting thereafter terminating with a vote of thanks to the chairman.

Western Counties and South Wales Telephone Company, Limited.

An adjourned meeting of the shareholders of the above company was held on the 13th inst. at the Royal Hotel, Bristol, for the purpose of sanctioning the raising of additional capital to enable the company to carry out contemplated extensions. Mr. Charles Nash presided.

Mr. H. F. Lewis, secretary and general manager, having read the notice convening the meeting,

The Chairman said it had been thought desirable to defer the arrangement for issuing a further amount of share capital, so that the first resolution attached to the report was withdrawn, and he now moved the second resolution, which was as follows:—

"That the articles of association be altered in manner following, that is to say: (a) The following article shall be substituted for article 71, namely, 'They may borrow any sum or sums of money on such security and terms as to interest, or otherwise, as they may deem fit, and may secure the same by mortgage or other debentures, or by bonds or other securities, or by any mortgage or charge of, or upon, the whole or any part of any property, funds, assets, or effects of the company, or its uncalled capital; but so that not more than £20,000 be owing at any time without the consent of a general meeting, and provided that no part of the said sum of £20,000 shall be borrowed without the consent of the United Telephone Company, Limited, and no borrowed money shall, without the like consent, carry interest at a higher rate than 6 per cent. per annum.' (b) In article 91 the word 'and' coming after the word 'agencies' shall be omitted, and the words 'trunk lines and new business' shall be inserted after the word 'branches.' The clause as amended shall apply as from the formation of the company."

The sum mentioned (the Chairman continued) might be sufficient to carry them through the present year, and they hoped that money would be obtained at a lower rate of interest than if share capital had been offered—probably not exceeding 5 per cent. He would just repeat what he thought he said at the last meeting, viz., that it was necessary they should have further capital in hand to enable them promptly to cover some further portion of the large district which formed the territory of the company. It would be their duty very carefully to select from the long list of places mentioned in the report those that were likely to give them a speedy return, and to arrange for opening exchanges in them, and also for connecting them, where desirable, by trunk lines. The only other point, he thought, was that it would not be necessary to borrow the whole of this money at once. That would be done at intervals as required. The last clause of the resolution was only inserted for the purpose of removing ambiguity and making the meaning of the clause plain. There had been a doubt as to whether it included trunk lines or not, and there would be no doubt about it any longer, as these words made the matter perfectly plain. He would only add that the general progress of the company continued to be very satisfactory, and that from week to week they were getting considerable accessions of business. Since they last met there were two places where arrangements were now in progress for speedily opening exchanges—he referred to Cheltenham and Swindon. Perhaps they might not be very valuable in themselves, but Cheltenham, when connected with Gloucester and the Stroud district, and Swindon, if connected with Bath and Bristol, would, he believed, bring a very considerable increase to their business.

Mr. Mark Whitwell seconded the motion, which was carried unanimously.

The Chairman said he should like to supply an omission he made at the annual meeting in June by expressing what he was sure was the feeling of the directors, their high appreciation of the great energy and ability of Mr. Lewis, the general manager. During some very heavy work that had been going on lately, Mr. Lewis had been very ably supported by the members of the staff. They had often had to work long hours. That they had done willingly, and he thought it was only due to them that it should be mentioned.

Mr. Henry Fedden said he had seen a great deal of Mr. Lewis's work and would like to confirm what the chairman had said in regard to it. He never knew a man who was more earnest in his work than Mr. Lewis, who had shown a thorough determination to make the company a success.

Commander D. M. Forsyth, R.N., also testified to the great help which Mr. Lewis had rendered, both in the formation of the company and in its subsequent development.

Mr. Lewis briefly returned thanks and the meeting terminated.

West African Telegraph Company, Limited.

THE third ordinary general meeting of this company was held at the offices, 98, Cannon Street, E.C., on Friday last, the 18th inst., when the chairman, Sir Frederick J. Goldsmid, C.B., K.C.S.I., presided. The directors' report submitted to the meeting appeared in our last issue.

Mr. R. N. Moir, the Secretary, having read the notice convening the meeting.

The Chairman said he thought they would find that the promises made, or the expectations held out at the last meeting, had been as far as possible realised. There were one or two things over which they really had no power; for instance, the traffic had not increased to the extent they would have liked to see; but, in other respects, the working had been satisfactory, and the whole line was in good condition. It was shown last year that the amount of revenue was somewhat small, but no definite explanation was required, because it was shown that the receipts were really for three months only, while the expenditure was for nearly the whole of the year. This year it had been different, and the income and expenditure might be much more fairly contrasted. Then, again, last year he had to explain that in starting a line there were a great many expenses which naturally occurred in the first year of working an undertaking of that kind, and which would not occur again; this year, although it was not actually the year of starting, there were still many expenses which would not necessarily follow in after years. It was satisfactory to know that the French subsidy had been paid up to the end of 1887, and the Portuguese up to September of last year, so there was every reason to suppose that those payments would be regular, and that their accounts might be kept in a systematic groove. Taking the first five months of this year, and comparing with the corresponding period of 1887, after making due allowance for interruptions, they might fairly consider that the traffic had increased at least 15 per cent. For the present they must rely upon their guarantee and subsidy, hoping for better results in the near future, when the system would be connected with the Cape. It was satisfactory to know, taking the last returns, that the traffic was still slowly increasing, and that the tendency was in the right direction. They had endeavoured to economise the working expenses by giving over two of their stations to the African Direct Telegraph Company. The cost which this arrangement would entail would be far more than compensated by the saving in the cost of establishments. He had received a letter from Mr. Robert Gray, who unfortunately was not able to be present, in which he stated that the India-Rubber Company was working earnestly towards the completion of the line to the Cape of Good Hope, and he had every hope that by the end of this year the connection would be made. When the new lines were completed the West African property would be enhanced in value by the new traffic which would be attracted. The Chairman concluded by moving the adoption of the report and the payment of a dividend of 3s. per share.

Sir Henry Mance seconded the motion, which was carried unanimously.

The appointment of Mr. E. March Webb to a seat at the board, the re-election of Mr. E. K. Gray as a director, and of Messrs. C. Kemp, Ford & Co., as auditors, concluded the business of the ordinary meeting.

An extraordinary general meeting was then held, at which a resolution was passed making a necessary but formal alteration in the articles of association.

A vote of thanks to the chairman and directors terminated the proceedings.

The Globe Telegraph Trust Company, Limited.

The directors have declared a final dividend of 3s. per share, less income tax, on the preference shares, and of 3s. per share on the ordinary shares, free of income tax, making with the previous payments, a dividend for the year of 6 per cent. on the preference shares, and 3½ per cent on the ordinary shares.

Anglo-American Telegraph Company, Limited.

The directors have resolved to declare an interim dividend for the quarter ending June 30th, 1888, of 5s. per cent. on the ordinary stock, and 10s. per cent. on the preferred stock, less income tax, payable on August 1st to the stockholders registered on the books of the company on July 10th, 1888.

Telegraph Construction and Maintenance Company, Limited.—The half-yearly meeting of this company was held at the offices, 38, Old Broad Street, on Tuesday, under the presidency of Sir Daniel Gooch. The business was purely formal, the chairman stating that the business was in a satisfactory condition, and that an interim dividend of 12s. per share would be paid.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 15th, 1888, after deducting the fifth of the gross receipts payable to the London Flatting-Brazilian Telegraph Company, Limited, were £5,700.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th July are £3,325, as compared with £2,204 in the corresponding period of 1887.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending July 15th amounted to £4,500.

NEW PATENTS—1888.

9835. "Improvements relating to switches for electrical purposes." W. MACKIE. Dated July 6.

9844. "Improvements in the construction of steam boilers, or generators for the economical generation of steam, either with or without the aid of electricity or electrical heat." E. N. BARNARD. Dated July 6.

9854. "Improvements in and connected with secondary batteries or electrical accumulators." L. BRISTOL. Dated July 6.

9907. "An improvement in electric current and tension meters." M. VON DOLIVO-DOBROWOLSKY and the COMPANY ALLOHMANN ELEKTRICITÄTS-GESELLSCHAFT. Dated July 7.

9910. "Improvements in and relating to continuous current dynamo-electric machines." G. KAPP. Dated July 7.

9912. "A combined automatic magic lantern and electric apparatus for mechanically exhibiting in succession by day or night views, photographs, or other subjects, consecutively, whenever desired." G. HUGHES. (Communicated by V. Bonnet, H. Lissagaray, Armand Richard, Alfred Richard, and N. Grumbach, France.) Dated July 7.

9927. "Improved electrical make-and-break switch for charging circuits of secondary batteries, and automatic cut-outs for other circuits." G. V. FOWLER and E. W. LANCASTER. Dated July 9.

9928. "Improvements in electrical regulators and armatures for dynamo-electric machines and motors." G. V. FOWLER and E. W. LANCASTER. Dated July 9.

10088. "Improvements in and connected with primary batteries." J. V. SHERRIN. Dated July 11.

10092. "Improvements in the means or apparatus for supplying electricity to tramcars or other vehicles." A. L. LINEFF. Dated July 11.

10098. "Improvements in magneto-electric calling or signalling mechanism used for telephonic or telegraphic purposes." J. S. LEWIS. Dated July 11.

10101. "Improvements in ships' compasses." J. VON PRICHL. Dated July 11.

10102. "Improvements in electric batteries." W. E. LAKE. (Communicated by Lacombe & Co., France.) Dated July 11.

10107. "Improvements in casing used for electrical conductors." C. S. SNELL. Dated July 11.

ABSTRACTS

OF PUBLISHED SPECIFICATIONS, 1887.

7042. "Improvements in electric arc lamps." F. G. CHAPMAN and F. M. DEARING and W. G. CHAPMAN. Dated May 13. 8d. The inventors arrange the positive and negative carbon poles to meet one another at right angles in the form of a T, the positive pole being thus practically divided into two parts placed horizontally one on each side of the negative pole which is placed vertically, the current being divided into "parallel" through the two ends of the positive pole and thence to the negative forming the arc. The claims are 5 in number.

9011. "Improvements in the construction of dynamo-electric generators and motors." E. JONES. Dated June 24. 8d. The inventor forms the brush of a bundle of fine copper wires, or other suitable material, of any suitable length. This bundle is first dipped in a suitable lubricant, and is then inserted in a metal tube, say of thin brass, and is soldered to one thereof. The tube is then submitted to pressure in a mould, or otherwise, by which means it is flattened out, and a number of serrations are formed on its under side to receive the edge of a clip forming part of the holder, and by which the brush is secured in the holder. The brush holder consists of a two-armed bracket, which is clamped on to the rod, and having in each arm a slot or guide hole to receive the brush. Secured to the brush is a spring or its equivalent, to which the clip before mentioned is attached, and by means of which the brush is kept in contact with the commutator with a regular pressure, the tension being adjusted by means of the clip according to requirements. The claims are 2 in number.

9256. "Improvements in and apparatus for regulating the speed of dynamos employed on railway trains for lighting the same." J. L. YULY and W. ANDREWS. Dated June 29. 8d. Claims:—1. In an apparatus for regulating the speed of dynamos for lighting railway trains the use of expanding pulleys, substantially as described. 2. In an apparatus for regulating the speed of dynamos for lighting railway trains, the combination of the cone pulleys and belts for the purpose specified. 3. The improved apparatus for regulating the speed of dynamos for lighting railway trains, substantially as described with reference to the accompanying sheet of drawings and operating as specified.

9829. "Improvements in dynamo-electric machines." T. STANLEY. Dated July 13. 8d. Consists in constructing the machine with a substantial iron frame enclosing a single pole magnet and armature in lieu of two poles opposite to each other as heretofore. The armature is carried in bearings resting upon the frame aforesaid which completely encircles both the single magnet and the armature. The claims are 3 in number.

9904. "Improvements relating to the production of insulating coatings or linings in electrolytic apparatus." L. GRABAU. Dated July 14. 8d. The parts of the electric decomposing apparatus which are to be insulated or protected are provided with a coating which is not attacked either by the molten mass to be decomposed or by their separated or single ingredients. This is achieved by cooling the parts of the apparatus which are to be insulated so thoroughly that on the cooled surfaces the liquid mass to be decomposed congeals and forms an insulating or protecting crust. This cooling is effected by making the parts to be cooled, with double walls, whereby spaces are formed which are adapted to convey cooling liquids or cooling gases, for example, cold air. The claims are 4 in number.

10195. "Improvements in dynamo-electric machines." J. P. HALL. Dated July 21. 11d. Relates to letters patent No. 9,583 dated July 24, 1886. The inventor casts the bedplate, the standards for carrying the pedestals and the keeper together in one piece, and he forms each pole of the magnet of one piece of wrought iron, the core embracing that portion on which the wire is wound, which is preferably circular in section, and also the upper portion or pole piece which may be of any form desired. Holes are bored through the keeper portion of the bedplate to receive the ends of the magnet cores, which are preferably slightly reduced in diameter to form a shoulder which rests upon the bed, and he makes the cast iron keeper of such section that its resistance is not greater than that of the wrought iron parts of the circuit. The claims are 3 in number.

10240. "Improvements in field magnets." L. HANSON. Dated July 23. 6d. Claim:—In a field magnet, the casting of molten metal onto the end of soft iron wire for forming the pole pieces and yoke, substantially as shown.

10454. "Improvements in and relating to electrical signalling apparatus for domestic and other purposes." J. T. GERR and H. G. ELLERY. Dated July 27. 8d. Claims:—1. In electric signalling apparatus, the employment of an armature pivotted centrally on a horizontal axis, and carrying a flag or indicator at its lower end, in combination with two electromagnets arranged to act on the two ends of the said armature on opposite sides thereof, substantially as described. 2. In electrical signalling apparatus, the employment of a case having a sliding cover, substantially as described. 3. The manufacture and use of the improved electrical signalling apparatus, described and illustrated in the drawing.

10575. "Improvements in instruments for electric measurement." W. EMMOTT and J. H. RIDER. Dated July 30. 6d. Claim:—In electrical measuring instruments the use of a needle, so formed that its edge is of circular form, and of varying thickness of metal, for the purposes set forth.

13069. "Improvements in or relating to harmonic telegraphy." F. VAN EYSELBERGHE. Dated September 27. 11d. Consists of methods and combinations by means of which the greatest possible number of messages are sent simultaneously on the same wire or circuit. To attain this object the inventor combines a system of harmonic-multiplex with the other ordinary telegraph instruments, such as the Morse, Hughes, and others; and arranges them so as to work simultaneously the same wire or circuit. The claims are 29 in number.

CORRESPONDENCE.

Insulating Commutator Bars.

I shall be obliged if any reader of the REVIEW who has had experience in the insulation of commutator bars will kindly say what material he would recommend for a shunt wound machine 100 v. 72 a.

July 16th, 1888.

Chas. McLean.

Comparing Very Unequal Capacities.

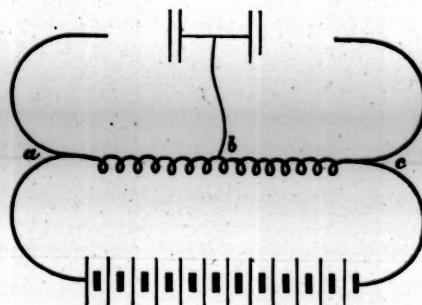
We observe that there is a correspondence going on in your columns regarding the proof of the formula to be used with the method for comparing very unequal capacities which was recently described by Dr. Fison to the Physical Society. It may therefore interest your readers to see the following proof, which we gave when we published this method of comparing very unequal capacities eleven years ago. In mentioning this we wish to remark, 1st, that a publication emanating from the University Press in Japan is very likely to escape the notice of English readers; 2nd, that the very ingenious key that Dr. Fison has devised and used with

the method has much increased its practical value, and therefore that no one is more grateful than ourselves for his taking up the subject.

Let two condensers of capacities, x, k , be charged so that the difference of potentials between their coatings is respectively x, e , and let each of the coatings of the first condenser be connected with one of the coatings of the second in such a way that the charges in the two condensers tend to neutralise one another; then, if v be the resultant difference of potential, it is easy to show that

$$x = k \frac{v + e}{x - v} \quad (1)$$

To find the ratio of x to e the best arrangement is, as usual, to measure the ratio of two resistances through which the same current is flowing, and this can be conveniently done if the apparatus is arranged as in the following figure.



One coating of each condenser is joined with the point, b , of the resistance coil, a, c , and the other coatings are charged respectively with the two wires coming from the two ends of the coil a, c ; these coatings are then insulated from the two wires and left connected together for a short time, for electric equilibrium to be established, when finally the resultant difference of potentials is measured with an electrometer, or the resultant charge with a galvanometer.

Let d be the deflection obtained on the electrometer or galvanometer, and let it be afterwards found that the difference of potentials between the two points, a, d , when measured by the electrometer produces a deflection, d' , or when used to charge the two condensers, joined up as one, gives such a charge that a small deflection, d'' , is produced on the galvanometer when the joint condenser is discharged; then if x is the unknown resistance between two points in the coil, a, c , which have a difference of potentials, v

$$x = \frac{D}{D'} (a d).$$

Consequently, substituting for x, e, v , in equation (1), the resistances to which these differences of potential are proportional we find

$$x = k \frac{D (a d) + D' (b c)}{D' (a b) - D (a d)}.$$

If one of the condensers has a very small capacity compared with the other, then the ratio of the resistances $(a b)$ to $(b c)$ will be very far from unity, consequently the charges in either condenser may be so small that it will be difficult to measure their difference. If, however, the larger of the condensers be extremely well insulated this difficulty may be overcome in the following way: make the ratio of $(a b)$ to $(b c)$ nearer equality so that when the condensers are charged their charges will be very unequal and the resultant charge (which, however, need not be measured) great, then insulate the condenser of larger capacity and only recharge the smaller one with the same electromotive force as before, again discharge it into the larger, and repeat this several times until the final potential or charge of the two condensers joined together is so small that it can be accurately measured with a delicate instrument. To determine the connection between the capacities and the final charge let x, k , be the capacities of the two condensers, A and B , respectively, and let x, e , be the electromotive forces employed in charging them, where x is much greater than k , but x and e not very unequal, then

the first charge on A	is x, e ,
" " " "	" $- k, e$,
" " resultant charge on A + B	" $x e - k e$,
" " " " " A alone	" $\frac{x e - k e}{x + k} x$,
" " " " " B alone	" $\frac{x e - k e}{x + k} x - k e$,
" second " " " A alone	" $\frac{x e - k e}{x + k} x$,
" " " " " B alone	" $\frac{x e - k e}{x + k} x - k e$,
or	$\frac{x^2 e - 2 x k e - k^2 e}{(x + k)^2} x$,

similarly the n th resultant charge on A alone is

$$\frac{x^n x - n x^{n-1} k e - \frac{n(n-1)}{1 \times 2} x^{n-2} k^2 e - \dots - k^n e}{(x+k)^n} x,$$

or
$$\frac{x^n (x+e) - (x+k)^n e}{(x+k)^n} x.$$

Consequently the difference of potentials between the coatings of the larger condenser after the small one has been discharged n times into it is

$$\frac{x^n (x+e) - (x+k)^n e}{(x+k)^n},$$

which we may suppose produces a deflection, D , on the electrometer, or the resultant charge in the two condensers will be

$$\frac{x^n (x+e) - (x+k)^n e}{(x+k)^n} (x+k),$$

producing the deflection, D , say when discharged through the galvanometer, then if D' is the deflection produced on the electrometer by the difference of potentials between the points, a and d , in the resistance coils, or if D' is the small deflection produced on the galvanometer when the two condensers, joined together as one, are charged with the same difference of potentials and discharged through the galvanometer, then substituting the resistances to which the electromotive forces are proportional we have

$$\frac{D}{D'} = \frac{x^n (a e) - (x+k)^n (b e)}{(x+k)^n (a d)},$$

or
$$\frac{x}{x+k} = \left\{ \frac{(a d)}{(a e)} \frac{D}{D'} + \frac{(b e)}{(a e)} \right\}^{\frac{1}{n}}$$

$$\therefore \frac{k}{x} = \left[\frac{1}{\left\{ \frac{(a d)}{(a e)} \frac{D}{D'} + \frac{(b e)}{(a e)} \right\}} \right]^{\frac{1}{n}} - 1.$$

If $(b e)$ is nought, that is if the small condenser is thoroughly discharged each time before being connected with the larger, then

$$\frac{k}{x} = \left\{ \frac{(a d)}{(a e)} \frac{D}{D'} \right\}^{\frac{1}{n}} - 1.$$

This equation can, however, be obtained directly in a still simpler way: for let x be the capacity of an insulated condenser of which the coatings are charged to a difference of potentials, x , and let k be the capacity of the other condenser which is uncharged, let the inside coatings as well as the outside coatings of the two condensers be respectively connected with one another, then if e be the resultant difference of potentials

$$e = \frac{x}{x+k},$$

therefore after n connections of the small condenser with the larger the resultant difference of potentials between the coatings of either will be

$$x \left(\frac{x}{x+k} \right)^n$$

$$\therefore \frac{D}{D'} = \frac{(a e)}{(a d)} \left(\frac{x}{x+k} \right)^n$$

or
$$\frac{k}{x} = \left\{ \frac{(a d)}{(a e)} \frac{D}{D'} \right\}^{\frac{1}{n}} - 1.$$

The former method of testing, however, in which the smaller condenser is charged each time with an electromotive force, e , before being connected with the larger will enable the test to be made in a shorter time, and so will be less affected by want of perfect insulation in the larger condenser.

W. E. Ayerton,
John Perry.

A Trade Association.

The subject of forming an association to represent the commercial interests of the electrical industry has been frequently under discussion during the past few years, and there is apparently a consensus of opinion in favour of some kind of organisation being formed to secure united action, but the chief reason why the past attempts to establish such combination have failed is the difficulty of defining the scope and limits of the proposed association.

We all recognise the necessity for combination in matters of common interest, but we are not all agreed

as to what our common interests are. This is probably attributable more to the peculiar conditions of the industry in this country than to any fundamental difference of opinion. My object, however, is not to discuss this, but to point out how I think the difficulty referred to can in a large measure be overcome.

The proposition before us now is that we should assist the London Chamber of Commerce to form an Electrical Trades Section. This is not a new idea, for it has often been spoken of, and was suggested by me to the Chamber more than a year ago. There were, however, at that time difficulties in the way of the scheme being carried out; but now that the Electric Lighting Act has been amended, we may expect the industry to enter upon a new phase, and united action will become more important than ever.

We are indebted to the editors of *Electrical Plant* for reviving the suggestion that we should avail ourselves of the organisation of the London Chamber of Commerce, and in view of the public meeting which the Chamber will shortly convene in regard to the matter, the present is an opportune time to point out the advantages which the proposed arrangement offers.

The Chamber consists of firms and individuals, and anyone feeling an interest in the transactions of the Chamber can become a member upon payment of an entrance fee of two guineas, and an annual subscription of one guinea. Its work is divided among different trade sections, which are again divided into sub-sections according to the needs of the respective industries.

The sections are composed of representative men selected from the members, and one member of each section is elected to the general council. In this way each trade is brought into communication through its representative with all the other trades represented by the Chamber, whilst the various trade sections are not precluded from taking independent action in regard to their own esoteric affairs. The status possessed by the Chamber would at once secure to the electrical industry an influence in Parliamentary and official matters which would be practically unattainable by a separate association formed under existing conditions. The Chamber has been established many years, has done much good work for other industries, and its organisation and its mode of procedure are well defined and intelligible, and the secretary of the Chamber has had a large experience in the best methods of promoting and defending trade interests. We should, therefore, have the enormous advantage of being relieved from the unprofitable work of defining the precise functions of an organisation, and of settling its constitution and rules. All that is necessary is, that those who are concerned with the commercial interests of the business should allow themselves to be nominated as members of the Chamber, and then elect a representative section or committee. We should not have to concern ourselves with questions of ways and means, for all necessary office accommodation, staff, and a good central place of meeting would be provided for us by the Chamber.

The monthly journal and the annual volume of proceedings published by the Chamber afford means of intercommunication, and of permanently recording the work of the Chamber in regard to our affairs. The facilities of the Chamber for obtaining reports on the state of the industry in other countries, and for collecting statistical information, are such as no separate association that we could form at present could hope to secure. The following extract from a recent annual report of the council will indicate the special advantages offered to individual members:—

"Although the more immediate object of the Chamber is to serve the interests of members in their collective sense, it is also sought, within the limits of impartiality and fairness, to assist individual subscribers, not only by the communication of information as to treaties, tariffs, prices, foreign legal procedure, foreign exhibitions, the registration of trade marks, and the issue of certificates as to local trade customs, but also by the influence of the Chamber being employed to obtain the support of H.M. Government to members' interests

in foreign countries. . . . It is not too much to say that there is very little information in or out of the office which cannot now be obtained and transmitted with the least possible delay."

It may, perhaps, be urged as an objection to the proposal that those members of the industry who are resident in the provinces would feel themselves excluded, but the membership of the Chamber is not limited to persons residing in the metropolis, and the inconvenience to which country members are put by the meetings being held in London must necessarily apply to every organisation having its head quarters in London. On the other hand, those members of the industry who join the provincial Chambers of Commerce are brought into communication with the members of the London Chamber by means of the Associated Chambers of Commerce, a central body which represents now some 70 Chambers of Commerce in all parts of the United Kingdom.

E. Gareke.

July 16th, 1888.

Telegraph Survey and Construction.

In the *ELECTRICAL REVIEW* of 18th April last you were good enough to publish a paper from me "On a New System of Survey and Construction for Railway Telegraphs," which to all appearance has not been acceptable to telegraph engineers.

True, one engineer did offer some criticism on my system in the *REVIEW* of 25th May, by admitting that it was new to most of the telegraph engineers, but condemning it off-hand as expensive, and at the same time detailing the system adopted by himself as an efficient, and, I presume, a preferable and cheaper one.

In acknowledging this letter in the *REVIEW* of 1st June, I said I would wait for further responses or repudiations from other telegraph engineers before replying to Mr. Neale; but as none such are forthcoming to this date, I will with your permission offer a few remarks on that gentleman's system.

It will be observed that Mr. Neale admits that he commenced to read with interest my paper on the subject of "A New System of Survey and Construction for Railway Telegraphs," thinking it was something *startling*, and, whilst failing to tell what in the nature of *startling* he expected, he in the same breath, as it were, repudiated my assertion that "hitherto the practice has been for railway telegraph engineers to trust the important part of the survey to inspectors or foremen, &c." (*Vide REVIEW* of 18th May.) This assertion, whilst made in no spirit of ill feeling towards any one, and without the slightest intention to give offence, has evidently startled Mr. Neale and induced him to set forth his own mode of survey, crude as I shall show it to be, against a system he acknowledges *new*, and, whilst *new*, too expensive, it may be presumed, to be thought of after recent disasters for a line of telegraph capable of weathering a storm.

Mr. Neale's Survey, *vide REVIEW* of 25th May.

1. *Distance between Poles.*—This is put down at 88 yards on straights, irrespective of the number of wires, and is to be reduced on curves apparently at the pleasure of the foreman in charge. There is surely some mistake here. For a line of telegraph, no matter how few the wires, 88 yards is excessive, and for a heavy or exposed line 60 to 70 yards on straights and easy curves, and down to 55 or even 50 yards on heavy curves is, in my opinion, ample for safety.

2. *Stay Wires.*—Stays are to be employed, but, again, the strength or ply of them is left to the discretion of the foreman.

3. *Measuring Distances for the Poles.*—The system of measuring from the rails is as old as the first line of telegraph erected in this country, and it is surprising that a telegraph engineer of the present day should refer to it. In such an antiquated system the possibility of reducing an acute curve in the rails to an obtuse curve in the telegraph, thereby lessening the

strain on the timber, the quantity of timber, as well as the mileage of wire, is altogether lost.

Thus:—



NEW METHOD.



OLD METHOD.

4. *Number of Men required on Survey Works.*—Mr. Neale is clearly wrong in saying, by my method 14 men are required to his five. I only employ six men on an extensive section, and where obstacles are ahead, and can do with four on an open and short section.

5. *Depth of holes for Poles.*—In Table II. Mr. Neale gives 4 feet 3 inches as the depth for poles up to 30 feet 3 inches, but I hardly think that any practical man will be prepared to follow this example on a trunk, or even on a branch line, however few the wires. A 4 feet hole for poles not exceeding 24 feet may suffice, but not for longer lengths, unless solid rock is encountered. Further, Mr. Neale's survey fails to instruct as to double poles, draw struts, &c., and altogether may be looked upon as not only imperfect but misleading.

Sirs, it was my intention to have concluded this letter by referring to the various reports on the subject of the serious destruction to the telegraphs of the country in recent years, notably on December 26th, 1886, and to enquire what our telegraph engineers were doing with a view of reducing these disasters to a minimum in the future, and thus, it may be hoped, avoid to some extent at least, the enormous outlay contemplated by Parliament in placing the trunk wires underground, to the possible gain of the commercial public, but to the undoubted serious loss to the railways, but the fear of encroaching too much on your space deters me from doing so on this occasion. I shall, however, trouble you in this direction later on, unless in the interval our telegraph engineers show some willingness to come forward and grasp this important subject with the view of improving the present slipshod system of telegraph survey and construction.

Apologising for having so far trespassed on your space,

Arthur E. Gilbert.

Highland Railway, Inverness,

July 14th, 1888.

P.S.—I would like further to embrace this opportunity of qualifying the remarks contained in my letter of May 18th, as to railway telegraph engineers leaving the important work of the survey and construction to others, by adding that such may not be the actual rule, and at the same time by withdrawing any reflection on the ability of the inspectors and foremen, amongst whom I willingly admit that I have, in my experience, met with men capable of receiving the necessary instructions and of being left in charge of the construction works after my personal survey. I must, however, say that such men have been the exception rather than the rule.—A. E. G.

Gaulard and Gibbs v. Ferranti.

I think some appreciative notice is due from me of the article on the Gaulard and Gibbs case in your issue of the 13th inst. But as the case will go before the Court of Appeal I refrain from making any further remark.

J. Dixon Gibbs.

July 16th, 1888.